DOCUMENT RESUME

ED 418 229 CE 076 079

AUTHOR	Briers, Gary; Lee, Jasper S.
TITLE	Rice Production and Marketing.
INSTITUTION	National Council for Agricultural Education, Alexandria, VA.; National Future Farmers of America Foundation, Madison, WI.
PUB DATE	1997-00-00
NOTE	170p.; Sponsored by Cedar Chemical Corporation.
PUB TYPE	Guides - Classroom - Teacher (052)
EDRS PRICE	MF01/PC07 Plus Postage.
DESCRIPTORS	*Agricultural Education; *Agricultural Production; Course Content; *Field Crops; Learning Activities; Lesson Plans; *Marketing; Secondary Education; *Teaching Methods; Units of Study; Vocational Education
IDENTIFIERS	*Rice

ABSTRACT

This guide contains lesson plans for use in secondary programs of agricultural education in geographical areas in which rice is produced. Six units and 13 problem areas are organized into teaching plans that cover the broad nature of rice production. The six units are: (1) determining the importance and history of rice production; (2) determining the biology of rice; (3) seeding rice; (4) culturing the rice crop; (5) harvesting and post-harvest management; and (6) marketing and processing. Each lesson includes objectives, followed by sections on instructional resources, preparation, presentation, review, application, and evaluation. A sample test, as well as transparency masters, are included. Suggested presentation times for each lesson are provided. The bibliography contains 21 references. (KC)

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ED 418 229

PRODUCTION Rice AND MARKETING

Agricultural Research Service, USDA (K7577-1)

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Preface

Rice production is continuing to expand in the United States and worldwide. This expansion is helping to support human life. In many nations, rice is the major source of nutrients in the diets of humans. The forecasts are that this trend will continue into at least the near future.

People who are involved in producing and marketing rice need to have appropriate education to efficiently go about their work. The plans presented here are for use in secondary programs of agricultural education in geographical areas where rice is produced. The content of the plans will introduce students to the important aspects of rice production.

Six units and 13 problem areas are organized into teaching plans. These units and problem areas cover the broad nature of rice production and marketing. The format chosen for the plans is one that has been widely used and accepted throughout the United States. This format is based on providing systematic, student-oriented instruction. In each lesson, the objectives are given followed by sections on Instructional Resources, Preparation, Presentation, Review, Application, and Evaluation. A sample test, as well as transparency masters, are included. Each plan has an Estimated Time. The time given is to cover the content of the plan with some enrichment with hands-on activities. It is likely that teaching times will vary with the instructional preferences of the teacher.

Students and teachers can make use of many additional resources, such as brochures and periodicals about rice production in the local area. It is also suggested that resources on the World Wide Web may be useful in some areas of rice production and marketing. References are made to web sites that might be useful in the various plans. One web site that may be particularly useful is the RiceWeb: http://www.cgiar.org/irri/riceweb/

Your assessment and experiences with this plan will be welcomed. Send them to the National Council for Agricultural Education, P. O. Box 15035, Alexandria, VA 22309-0035.

These instructional materials have been developed by Dr. Gary Briers, Texas A & M University, and Dr. Jasper S. Lee, Lee and Associates, Demorest, Georgia. The support of Cedar Chemical Corporation in sponsoring the development of these materials as a special project of the National FFA Foundation, Inc., is greatly appreciated.

For more information about Rice Production and Marketing instructional materials, contact the National FFA Foundation, P. O. Box 45205, Madison, WI 53744-5205; (608) 829-3105 or the National Council for Agricultural Education, P. O. Box 15035, 5632 Mt. Vernon Memorial Highway, Alexandria, VA 22309-0035; (703) 360-8832.

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Rice Production and Marketing

Unit I: Determining the Importance and History of Rice Production

Problem Area A: Determining the Importance of Rice

Estimated Time: 1-2 hours

Purpose/Goal: This problem area helps students understand the importance of rice as a worldwide human food source.

Learning Objectives: Upon completing this problem area, students will:
1. Explain how rice is important as human food.
2. Describe the nutritive value of rice.
3. Compare U.S. rice consumption with that of other countries.

Instructional Resources: The following instructional resources are recommended for use in teaching this problem area:

Essential: Sufficient copies of handouts HIA-1 and HIA-2 for each student. Transparency of TRIA-1.

Additional: Any reference materials on rice consumption and production. Students may use the World Wide Web to locate information on rice production and consumption. A good Web site for this introductory lesson is the Consultative Group on International Agricultural Research: http://www.cgiar.org/

Preparation: Use the following general strategy to introduce this problem area:

Provide each student with a copy of the handout HIA-1. Have students read this as homework, in supervised study, or orally in class. Afterward, ask students to name the three leading food crops in the world (rice, wheat, and maize). List them on the chalkboard. Number the order of importance based on the number of hectares produced (wheat = 1, rice = 2, and maize = 3).

This is a good time to integrate mathematics applications. Explain that hectare is a land measure that is most widely used in the world. One hectare (ha) is equal to 10,000 square meters or 2.471 acres. Hectares can be converted to acres by multiplying the number of hectares by 2.47. Have students convert the hectares planted to these three crops to acres, as follows: wheat is planted on 230 million ha, rice on 145 million ha, and maize on 130 million ha. (Acre equivalents are: 568, 358, and 321 million acres, respectively.)

Ask students to explain why large areas are planted to rice. Possible answers include: people like to eat it, rice is easy to grow, tradition, and profitable crop.

Move into the problem area by presenting the objectives using TRIA-1.

Presentation: Use the following summary of content and suggested teaching techniques to provide the instruction.

Summary of Content	Teaching Techniques
I. How important is rice as human food?	
A. Rice is used directly for human consumption.	A. Ask students to compare the use of rice with the use of wheat and maize.
1. Some wheat is used as animal feed.	
2. A major portion of maize is used for animal feed.	
B. World rice production is 485 million metric tons a year.	B. Explain that a U.S. ton (also known as a short ton) is 0.907 metric tons. Conversions can be made as follows: -U.S. ton to metric ton--divide U.S. tons by 1.102 -Metric ton to U.S. ton--multiply metric tons by 0.907
1. World rice production in U.S. tons is 535 million tons.	
2. A slight upward trend in total rice production exists.	
C. World annual per capita production of rice is 91 kg a year.	C. Explain that 1 kg equals 2.205 pounds. Have students multiply the number of kg by 2.205 for unmilled and milled rice.
1. Annual per capita consumption is the average amount consumed by all people in a year.	Ask a student to explain "calorie." (A calorie is a measure of heat energy. It is the amount of energy needed to raise the temperature of one gram of water one degree Celsius.) Since rice provides 20% of the human calories,
2. Processing yields 57 kg per capita of milled rice.	
3. This quantity produces 205,200 calories of food energy.	

4. Rice is the principal food for half of all humans.

5. The people of Asia eat 90% of all rice grown and consumed in the world.

6. Countries where rice accounts for the highest caloric consumption are Myanmar (formerly Burma) at 73% and Thailand at 66%.

ask students to explain the source of the other needed calories. (The explanation should involve other foods as sources of calories, such as corn, wheat, fruit, vegetables, and meat.)

6. Have students locate these countries on a world map. Other countries with large rice production should also be located, such as China and Bangladesh.

II. What is the nutritive value of rice?

A. Rice is hulled and milled in preparation for human consumption.

A. Bring examples of rough rice, brown rice, and milled rice to class. Have students crack and break open the rice kernels to explore the structure of the hull, bran, and grain.

1. Rice as harvested is known as rough or paddy rice because it has a hull on each grain.

2. The first step in processing rice is to remove the hull.

3. Rice that has been hulled is known as brown rice.

4. Milling is needed to remove the layer of bran on brown rice to make it white.

5. Bran is primarily used in livestock feed.

B. Nutritive value varies with how rice is prepared.

B. Have students refer to the table on rice composition on handout HIA-2. Call on members of the class to compare brown rice, milled rice, and rice bran. Ask them to explain the changes in nutrients resulting from the milling process.

1. Milling removes 80% of the thiamin from brown rice.

2. Boiling results in the loss of additional vitamins.

3. Milled rice is 89.8% starch and 7.7% crude protein.

III. How does rice consumption in the United States compare with other countries?

A. The annual per capita consumption of milled rice in the United States was 8 kg (17.6 pounds) in the mid-1990s.

1. Rice consumption has doubled in the United States in the decade of the mid-1980s through the mid-1990s.

2. U.S. rice consumption has had a greater per capita increase than any other nation.

A. Obtain the most recent edition of Agricultural Statistics from the U.S. Department of Agriculture. Look up information on rice production and consumption in the United States. Compare production and consumption trends.

B. The annual per capita consumption of rice in the United States is far below many other countries.

1. Countries with the highest per capita consumption of rice are Myanmar (186 kg), Thailand (157 kg), Bangladesh (130 kg), China (96 kg), Philippines (92 kg), and Japan (68 kg).

2. The largest increases in per capita consumption in countries other than the United States since 1960 have been 26% increase in Myanmar and 35% in China.

3. The largest decreases in per capita rice consumption since 1960 have been a 35% decrease in Japan and 12% in Bangladesh.

B. Use a globe of the Earth to locate the countries with the highest consumption of rice.

1. Use mathematic skills to convert kilograms to pounds for each of the major rice consuming countries.

2. Have students prepare short reports on the culture of the countries with the highest per capita consumption of rice.

Review: Call on different students to explain the content associated with each objective. State the objective and ask students to repeat the information that goes with it.

Application: Several application suggestions are offered here.
1. Students can apply integrated learning approaches with social studies and mathematics. The content should relate to other classes they may be taking.
2. Have students visit a supermarket and make a list of the different kinds of rice that are for sale. They should make notes that include brand name, product description, and cost per unit sold. Have them assess nutritive values of the different products by observing labels and extent of milling.

Evaluation: Evaluation should focus on the extent to which the students have achieved the objectives. Strategies include:
1. Observation of student performance in class.
2. Giving a written test (sample is attached).

Name_____

Test
Rice Production and Marketing

Unit I: Determining the Importance and History of Rice Production
Problem Area A: Determining the Importance of Rice

Instructions: Answer the following questions. Be sure to spell correctly.

1. How does the use of rice vary from wheat and maize?

2. Explain the term, "annual per capita consumption." What is the annual per capita consumption of rice in the United States?

3. The people of _____ eat 90% of the rice grown and consumed in the world.

4. How does milling change the nutritional value of rice? Explain.

5. What two countries have the highest annual per capita consumption of rice?

6. Compare changes in rice consumption in the United States with the Asian countries.

7. What is the nutritive value of milled rice?

8. What is paddy rice?

9. If the annual per capita consumption of rice in the United States is 8 kg, how many pounds of rice are consumed in a year by the people in the city or county where you live? _____ pounds

10. If 91 kg of paddy rice yields 57 kg of milled rice, what percent is lost in hulling and milling? _____ percent

Determining the Importance of Rice

Rice is the most important food crop in the world! The other leading food crops are wheat and maize (corn). Together, the three crops supply more than 50% of all calories consumed by humans. In land area harvested, wheat is the leader with 230 million ha, rice with 145 million ha, and maize with 130 million ha.

Rice is important as a human food crop because it is directly used for consumption. Compare this to maize. A major portion of maize goes for livestock and poultry feed. Maize is also used to make oils and other products for food and non-food uses. Some wheat is used for animal feed.

World Rice Production - World production of rough rice is 485 million metric tons. After the amount to seed the next crop is deducted, 91 kg remains for each person on the Earth. This 91 kg will produce 57 kg of milled rice. Each kg of milled rice produces 3,600 calories of food energy. This allows 560 calories per person each day or 20% of worldwide human requirements. Under ideal conditions, hunger would not exist today. It is the principal food for half of all humans. The people of Asia produce and eat 90% of all rice grown and consumed in the world.

Countries With High Rice Production and Consumption - Rice is a major crop and source of calories in many countries. In Asia, rice accounts for a remarkably high proportion of total caloric intake. In Myanmar, for example, 73% of the total food energy value of the population is from rice. In Thailand, roughly two-thirds of the calories are from rice. In these countries, a typical person eats 160 kg of husked rice each, or almost 0.5 kg per day.

Annual Per Capita Rice Consumption in Selected Countries

Country	*kg*	*Country*	*kg*
Bangladesh	130	Myanmar	186
China	96	Philippines	92
India	64	Thailand	157
Japan	68	United States	8

Beyond the Asian countries, rice seldom constitutes such a large portion of the human diet. However, nearly half of the national caloric total in Madagascar, Liberia, Sierra Leone, Guinea, Ivory Coast, Surinam, and Guyana is supplied by rice. By contrast, in the United States rice accounts for 2% of the calories consumed.

Rice consumption has been changing. In 25 years, rice consumption has increased 230% in the United States, 35% in China, 26% in Myanmar, and 6% in the Philippines. Some countries have had decreases, including 35% in Japan, 12% in Bangladesh, 3 % in Thailand, and 2% in India.

Rice Processing and Nutrition

Most rice is consumed in polished, cooked form. Steps to convert harvested rice to a polished form result in changes in nutritional content.

Harvested rice is known as rough or paddy rice. As harvested, the rice grains are in a hull. The hull is removed through a process known as hulling. The grains that result are known as brown rice because of a layer of brownish-colored bran that coats the grains. The brown rice is milled to remove the bran and produce polished white grains. The bran is used in feed for livestock because it is a good source of important nutrients.

With milling, much of the needed nutritional value of rice is lost from the grain. This loss is particularly important in countries where people rely heavily on rice in their diets. Polished rice can lead to dietary deficiencies when it is the major food. Polishing reduces nonstarch constituents. The structure of a grain is important in nutrition. The protein and vitamins decrease from the outside to the interior of a grain. Milling removes nutrients, most notably protein, vitamins, and minerals. People who eat polished rice as their major food item may develop beriberi, which is caused by a deficiency of thiamin (vitamin B_1).

Milling removes 80% of the thiamin from rice. Though brown rice contains these nutrients, it is not popular because of three reasons: requires more fuel for cooking, may cause digestive disturbances, and the oil in the bran layer tends to become rancid during storage, especially at high temperatures. Parboiling rough rice before milling allows a portion of the vitamins and minerals to permeate the grain and be retained. Parboiling is common in India and Bangladesh.

How rice is prepared also influences the nutrition level. Most rice is prepared by boiling or steaming. Bean curd, fish, vegetables, meat, and spices may be added as locally available or the economic situation permits. Precook rinsing and boiling milled rice results in additional loss of nutrients.

Composition of Brown Rice, Milled Rice, and Rice Bran

Constituent	*Brown Rice*	*Milled Rice*	*Rice Bran*
Starch (%)	75.9	89.8	9.7
Crude Fiber (%)	0.8	0.1	9.7
Crude Fat (%)	3.3	0.6	22.8
Crude Protein (%)	8.4	7.7	15.7
Iron (mg/100g)	2.0	0.7	15.7
Lysine (g/16g N)	4.1	3.8	5.6
Thiamin (mg/100 g)	0.3	0.1	2.3
Niacin (mg/100 g)	4.7	1.6	29.8

Source: Eggum, B. O. *The Nutritional Value of Rice in Comparison With Other Cereals*. Manila, Philippines: International Rice Research Institute, 1979.

OBJECTIVES

Unit I: Determining the Importance and History of Rice Production

Problem Area A: Determining the Importance of Rice

Upon completion:

1. Explain how rice is important as human food.

2. Describe the nutritive value of rice.

3. Compare U.S. rice consumption with that of other countries.

Rice Production and Marketing

Unit I: Determining the Importance and History of Rice Production

Problem Area B: Determining the History of Rice Production

Estimated Time: 1-2 hours

Purpose/Goal: This problem area helps students understand the important historical perspectives of rice production.

Learning Objectives: Upon completing this problem area, students will:
1. Trace the history of worldwide rice production.
2. Explain the emergence of rice production in the United States.
3. Identify major areas where rice is currently produced in the United States.

Instructional Resources: The following instructional resources are recommended for use in teaching this problem area:

Essential: Transparencies TRIB-1, TRIB-2, TRIB-3, and TRIB-4.

Additional: Any reference materials on the history of rice production.

- Information in *Introduction to Plant and Soil Science* (available from Interstate Publishers, Inc.) on rice production will be useful.

- Resources of the Internet and World Wide Web may be useful. A good web site is the RiceWeb: http://www.cgiar.org/irri (Click on the appropriate RiceWeb contents and chapters.)

Preparation: Use the following general strategy to introduce the problem area:

Have students recall the previous problem area by asking where rice is grown today. Use this to followup by asking where and when rice culture began (evidence is that it began in southern China about 5000 BC). Ask if people had rice before this time (yes, the grain was gathered from rice plants that grew wild). Ask students to offer their impressions about how rice was first grown as compared to today (by hand in small areas as compared to large scientifically-farmed fields today in the United States).

Move into the content of the problem area by presenting the objectives using TRIB-1.

Presentation: Use the following summary of content and suggested teaching techniques to provide the instruction.

Summary of Content	Teaching Techniques
I. What is the history of worldwide rice production?	
A. Archeologists have evidence that rice has been used for food for thousands of years.	A. Ask students to describe the work of archeologists. (Archeology is the study of prehistoric people and their cultures.)
1. Rice was first gathered from wild plants.	Ask students to name examples of plants or products of plants in the local area that people gather wild. (Examples may include hickory nuts, blackberries, and mushrooms.) Have students explain why they are gathered wild rather than cultured.
2. Cultivation first began 5,000 years BC in southern China and parts of Thailand, Laos, and Vietnam.	Use a world map to locate the major countries where rice production began.
3. Rice cultivation spread from southern China to northern China, Japan, Korea, India, Indonesia and other areas of Asia.	
B. Explorers and traders carried rice to other parts of the world.	B. Ask students to define explorer and trader and explain how they are different.
1. Iran and Syria began rice cultivation about 300 BC.	
2. Rice cultivation likely began in Africa some time after Syria.	List the names of countries and dates at which rice culture began.
3. Rice was first cultivated in Europe about 700 AD, when it was introduced from Africa into Spain by conquering Moors of northwest Africa.	

4. Rice cultivation began in Italy several hundred years after it started in Spain.

4. Use a world map and have students locate the various regions and countries involved.

5. Spanish explorers took rice to the West Indies and South America beginning in the 1400s.

II. What is the history of rice production in the United States?

A. Rice was introduced early into the colonial area of the United States.

A. Use a map of the United States and have students locate the colonial area. Ask them to name the states that are involved.

1. The first production was likely in Virginia in the early 1600s.

2. The first commercial rice production was in South Carolina in the mid-1680s.

- By the late 1600s, rice was being exported from South Carolina, 60 tons shipped to England in 1698.

- Commercial cultivation was encouraged because rice was used as legal tender (money).

Ask students to explain the meaning of commercial cultivation (rice grown for selling to others).

B. Rice cultivation spread rapidly in the Southeastern states.

B. Ask students to explain why rice production moved as it did in the United States.

1. By the early 1800s, rice production had spread to North Carolina, Georgia, Florida, and areas of Tennessee and Kentucky.

2. By 1839, rice cultivation had moved into the Mississippi Delta area and Gulf Coast region.

- Its cultivation reached from South Louisiana to southern Illinois.

- The delta area was found to be ideal for rice.

- About 100,000 acres of land were in rice production in 1839.

Ask students to describe the climate of the Mississippi River delta. How is it suited to rice production?

C. Where rice was produced resulted from the principle of comparative advantage.

1. This is an economic principle that explains why changes occur in where a crop is produced.

2. The principle is: resources are used where they will produce the greatest returns.

- Even though different locations could grow rice, some were better suited than others.

- Increased labor costs and declining yields in the early areas of production resulted in rice shifting to the larger and flatter fields of the Gulf Coast and Delta Regions.

- South Carolina dominated rice production until it was surpassed by Louisiana in 1890 because of comparative advantage.

C. Use the chalkboard or transparency TRIB-2 to list the definition of comparative advantage. Ask students to name examples of crops grown in the local area and relate these to comparative advantage.

D. Rice production in the United States has expanded from the early years in South Carolina.

D. Use a map and have one or more students point out the direction of movement of rice production.

1. In 1839, 90 million pounds of rice were produced, with 67 million pounds being produced in South Carolina.

2. Rice production doubled by 1859 to 180 million pounds.

3. By 1900, rice production in the United States was 250 million pounds, with almost none produced in the eastern states where production had first started.

Have students calculate the pounds increase in rice production in the United States between 1839 and 1900 (answer: 160 million pounds).

III. Where are the major areas of rice production in the United States today?

A. Because of comparative advantage, rice production has shifted from the areas where it was first produced in the United States.

1. Most locations that produce rice today were growing rice in the late 1800s except for California.

2. Rice production began in California in 1912.

- The first California location was in the Sacramento Valley.

- Later, rice production began in the San Joaquin Valley.

Use a map of California to locate the Sacramento Valley and the San Joaquin Valley. Note major rivers and other geographical features.

B. Leading states in rice production today are (in order from most to least) Arkansas, California, Louisiana, Texas, Mississippi, and Missouri.

B. Use the chalkboard or transparency TRIB-3 to list the six major states in rice production today.

1. The Mississippi River Delta area in Arkansas, Mississippi, Missouri, and Louisiana is now a major source of rice.

- Arkansas is by far the leading state.

- The greatest increase in recent years has been in Mississippi.

- The rice grown in this area is long-grain and often used for consumption in the United States.

2. Southwestern Louisiana and the Coastal Prairie of Texas are other locations in the South where rice is grown, primarily long-grain rice.

3. Most rice production in California is now in the Sacramento Valley.

- California primarily grows medium- and short-grain rice varieties.

- Much of the rice grown in California is exported.

Use the chalkboard or transparency TRIB-4 to explain the classification of rice by length of grain.

Use samples of different grain lengths for students to measure and classify.

Have students visit a local grocery store and prepare a list of different rice products classified by grain length.

Use the chalkboard or transparency TRIB-5 to show the acres of rice by kernel length produced in the United States.

Review: Have students in the class summarize the major content of the lesson as related to the objectives. List each objective using the chalkboard or transparency to help the students in the process. This is also one approach to evaluating the learning that has occurred.

Application: Several application suggestions are offered here.
1. Students may be able to integrate learning about the history of rice production with social studies classes. In some cases, comparative advantage will be a part of economics or farm management classes.
2. Students who are involved with supervised experience related to rice can apply the content in assessing future trends in rice production.
3. Use the information on the history of rice production as background for independent study by students. Class research projects, term papers, and similar application activities may be used.

Evaluation: Evaluation should focus on the extent to which the students have achieved the objectives. Strategies include:
1. Observation of student performance throughout the lesson and during the review.
2. Giving a written test (sample is attached).
3. How students use their understanding of where rice is produced in future lessons will help assess learning.

Name_____

Test
Rice Production and Marketing

Unit I: Determining the Importance and History of Rice Production
Problem Area B: Determining the History of Rice Production

Instructions: Answer the following questions. Be sure to spell correctly.

1. Where did rice production originate? _____

2. Before rice was cultivated, how did people have rice available?

3. How did rice production move from its origin to Europe?

4. _____ was the first colony where rice was grown in the United States.

5. The first commercial production of rice in the United States was in _____ _____.

6. What is the principle of comparative advantage?

7. What six states are the major producers of rice in the United States today? (List in order from most to least production.)

_____

8. What is the difference in the rice grown in California and other areas of the United States? Explain.

9. Most rice in California is produced in the _____ Valley.

10. The greatest increase in rice production in recent years has been in the state of _____.

OBJECTIVES

Unit I: Determining the Importance and History of Rice Production

Problem Area B: Determining the History of Rice Production

Upon completion:

1. Trace the history of worldwide rice production.

2. Explain the emergence of rice production in the United States.

3. Identify major areas where rice is currently produced in the United States.

COMPARATIVE ADVANTAGE

An economic principle that explains why changes occur in where a crop or other commodity is produced.

Comparative advantage is: resources are used where they will produce the greatest returns.

Each producing area discovers its own most profitable niche for specialization.

One example: the movement of rice production from South Carolina to other locations in the United States.

RICE PRODUCTION IN THE UNITED STATES

State	Amount Produced* 1938	1963	1994
Arkansas	4,372	18,318	62,094
California	3,769	14,013	36,271
Louisiana	9,337	16,891	24,108
Mississippi	0	1,911	12,985
Missouri	0	202	4,557
Texas	6,151	18,934	16,095
Total	**23,629**	**70,269**	**156,110**

*1,000 cwt

Source: USDA

CLASSIFICATION OF RICE BY GRAIN LENGTH

Short-Grain Rice - kernels are less than 5 mm (one-fifth inch) long

Medium-Grain Rice - kernels are 5 to 6 mm (one-fifth to one-fourth inch) long

Long-Grain Rice - kernels are 6 to 8 mm (one-fourth to five-sixteenths inch) long

ACREAGE PLANTED TO RICE BY KERNEL LENGTH IN THE UNITED STATES

State	Kernel Length Short	Medium	Long
		(1,000 acres)	
Arkansas	3	157	1,070
California	13	410	14
Louisiana	0	215	315
Mississippi	0	0	245
Missouri	0	0	93
Texas	0	7	291
Total	**16**	**789**	**2,028**

Source: USDA, 1994.

Unit II: Determining the Biology of Rice

Problem Area A: Determining the Characteristics of Rice

Estimated Time: 2-4 hours

Purpose/Goal: This problem area provides basic information about the unique characteristics of rice as a plant.

Learning Objectives: Upon completing this problem area, students will:
1. List the scientific name for rice.
2. Distinguish between rice and wild rice.
3. Describe unique features of rice as a plant.
4. Explain the general requirements for the growth of rice plants.

Instructional Resources: The following instructional resources are recommended for teaching this problem area:

Essential: Transparencies of TRIIA-1, TRIIA-2, TRIIA-3, TRIIA-4, TRIIA-5, and TRIIA-6.

Additional: References on general biology may be useful. The book entitled *Introduction to Plant and Soil Science and Technology* will be useful. A good site on the Internet and World Wide Web is: http://www.cgiar.org/irri/riceweb/

Preparation: Use the following general strategy to introduce the problem area:

Since rice is a plant, have students name and explain major characteristics of plants. List the characteristics on the chalkboard and include key terms that explain each. Here is a summary of the major characteristics of plants that would be appropriate to include in preparing the students for the lesson on rice botany:

Photosynthesis - the process used by plants to make food
Rigid cell walls - plant cells have walls that are rigid (animal cells have only membranes that make the cells pliable)
Anchored - plants cannot move about as do most animals
Give off oxygen - plants use carbon dioxide in photosynthesis and release oxygen into the air

Ask students to explain how plants are living organisms. They have life cycles and carry out living processes. Plants are made of many cells and must

have food to live.

Move from the preparation into presentation of the content for the problem area. Present the objectives by using transparency TRIIA-1.

Presentation: Use the following summary of content and suggested teaching techniques to provide the instruction.

Summary of Content	Teaching Techniques
I. What is the scientific classification of rice?	
A. Scientific classification is a modern system used to distinguish between and show relationships among different living organisms.	A. Use the chalkboard or transparency TRIIA-2 to define taxonomy and list the stages in the classification system.
1. Taxonomy is the science of classification.	
2. Modern scientific classification uses a seven-stage system; the stages become more specific moving downward: Kingdom Phylum or Division Class Order Family Genus Species	2. Indicate that all living organisms are placed in five kingdoms (monera, protista, fungi, plant, and animal). Have students refer to *Introduction to World AgriScience and Technology* or a high school biology textbook for information on the kingdoms and scientific classification.
3. The most frequently used part of the classification system is the genus and species. - All organisms have a scientific name formed by combining the genus and species.	3. Indicate that genus and species are written underlined or in italics and that the first letter of the genus is capitalized.

- Improved species of rice are known as varieties.

- A variety is a group of related organisms within a species, with differences too small to become a different species.

- A cultivar is a variety that is cultivated and was developed by scientists because of certain desired characteristics.

B. Scientists have identified about 20 different species of rice.

1. Only two species of rice are cultivated today--Asian and African.

2. Asian rice is the dominant species in the world today.

- The scientific name for Asian rice is *Oryza sativa*.

- Several different varieties of Asian rice are grown in the United States, with each variety having unique characteristics for adaptation where it is grown.

- In the southern United States, rice varieties are given names such as Newbonnet, Gulfmont, and Millie.

- In California, rice varieties are given names based on length of kernel and a numbering system, such as S-201 (an early maturing short-grain rice) and M-401 (a late maturing medium-grain rice).

B. Use the chalkboard or transparency TRIIA-3 to list the two major species of rice that are grown. Be sure students know how to spell and properly write the scientific name of Asian rice.

- Have students determine the varieties of rice that are planted in the local area, if rice is grown. They can contact a local seed dealer or a department of agriculture in a college.

3. The scientific name for African rice is *Oryza glaberrima*--grown primarily in West Africa.

II. What is the distinction between rice and wild rice?

A. The "wild rice" of North America is not rice but a native grass often known as Candada rice or Indian rice.

A. Use samples of wild rice from a supermarket and compare the grain structure with rice.

1. The species of wild rice vary, with two being most common: *Zizania aquatica* and *Zizania palustris*.

2. Wild rice plants may reach heights of 10 feet with blades 1 ½ feet long and 2 inches wide.

3. As a food, wild rice is similar to rice and is often mixed with rice.

B. Wild rice is cultivated as a food delicacy and as an ornamental plant around the borders of ponds.

B. Cook samples of rice and wild rice. Have students compare color, texture, flavor, and other features.

III. What are the unique features of rice as a plant?

A. Rice is an annual marsh grass that grows best in warm, humid climates.

A. Ask students to explain the terms "marsh" and "grass." (A marsh is an area of water-logged soil. A grass is a plant that has jointed stems and blade-like leaves with parallel veins.)
- Use a rice plant or a sketch on the chalkboard to illustrate tillering.

1. Rice is a semiaquatic plant that grows erect with narrow parallel-veined leaves.

- One seed and plant may send up 20 or more tillers (stem structures) depending on plant spacing (plants spaced closer together have fewer tillers).

- Flowers and grain heads are borne on the ends of the tillers in panicles.

2. The major parts of a rice plant are:

- roots--anchor the plant and absorb water and other nutrients.

- stems--the erect part of the rice plant that grows opposite the roots and supports leaves and panicles; tissue in the stem conducts sap to the leaves and manufactured food to the roots.

- leaves--carry out photosynthesis for the rice plant; have parallel veins and attached to the stems.

- panicles--loose flower structure at the end of a stem for producing grain; stems divide into small branch-like structures in the panicle.

3. Rice may be classified by water requirement.

- Paddy rice (also known as lowland rice) is grown in continuously flooded fields.

2. Use a sketch on the chalkboard or transparency TRIIA-4 to illustrate the major parts of a rice plant.

-Have students make sketches of a rice plant and label its major parts.

-Ask students to explain the purposes of each of the major parts.

-Bring a panicle to class for students to examine. (If rice isn't available, substitute another grass that has a similar panicle such as oats or a wild grass.)

-Ask a student to describe photosynthesis. (Use references, if needed, such as *Introduction to Plant and Soil Science and Technology* or a biology book.)

- Use the chalkboard or transparency TRIIA-5 to illustrate the two classes of rice based on water requirement.

- Upland rice is grown in fields without standing water but ample water often supplied through irrigation.

4. Unlike most grains, rice seed can germinate and the roots çan thrive submerged in water.

B. Rice may be classified on characteristics of the starch and aroma.

1. The contents of the grain may vary from waxy to translucent (allow light to pass through).

1. Ask students to explain translucent. Have them to examine rice kernels to understand how they are translucent. (Place kernels on a light table or hold them up to light in a clear glass or plastic container.)

- These features have to do with the presence or absence of chemical substances known as amylose and amylopectin.

- Most rice grown in the United States is to some extent translucent.

2. Aromatic (scented) rice is grown on a limited basis in India and Southeast Asia.

C. Rice cultivars vary in days to maturity, ranging from somewhat less that 90 days to 165 or more.

C. If grown in the local area, have students determine the days to maturity of common varieties produced in the area.

1. Maturity is reached when the grain heads are formed.

- Grain formation is slow in hot weather; therefore, planting so that grain is formed in the late summer after the weather begins to cool results in a larger crop.

-Ask a student to describe the local climate in terms of the weather cooling near the end of summer.

IV. What are the general requirements for rice culture?

A. As a plant, the culture environment must meet the needs of growing rice plants.

B. The conditions needed for plant growth include: light, temperature, air, water, soil with adequate nutrients, and pest control.

B. Use the chalkboard or transparency TRIIA-6 to list the conditions needed for rice plants to grow. Ask students to explain how these are different from other plants.

1. Most rice grown in open fields receives adequate sun light for growth; however, large trees that shade a field may reduce production.

2. Rice grows best in warm climates, with planting occurring in the spring when the minimum air temperature is 65-70° F.

2. Ask students the date when the minimum air temperature in the local area is 65-70°F.

3. Because rice is often planted and grown partially submerged in water, it has the unique ability to live in the absence of free oxygen by a process known as anaerobic respiration.

3. Have students research "anaerobic respiration" and give an oral report in class or turn in a written report.

- Rice stems and leaves begin taking oxygen from the air when they emerge above water.

- The parts of a rice plant above the water carry oxygen to the parts that are submerged.

- Other cereal grain plants will not grow submerged in water.

4. Rice requires adequate nutrients to grow properly. - Fertilizer is essential in most soil but should be used based on soil analysis. - Rice requires considerable nitrogen, with rates of fertilization higher than most crops. - Phosphorus and potassium are usually incorporated in the soil prior to planting.	4. Make an analysis of soil in the local area. Have students use a test kit or send a soil sample to a laboratory for analysis. -Obtain brochures about the fertilization needs of rice in the local area. Have students interpret the results of soil analyses in terms of fertilizer needs for rice production.
5. Rice is subject to damage by weeds, insects, and diseases and these must be properly controlled to assure a good rice crop.	5. Invite a rice grower to be a resource person in class and discuss the major pest problems and how the pests are controlled.

Review: Again list the objectives for the lesson on the chalkboard or with transparency TRIIA-1. Call on different students to discuss the content associated with each objective. Re-teach any areas where students appear to need more information.

Application: Several application suggestions are offered here.
1. Have students conduct library research on the botany of rice. This may include using the Internet and World Wide Web to investigate ecosystems for rice production. The web site is: http://www.cgiar.org/irri/crucial.htm
2. Students who have supervised agricultural experience in rice production or other areas can apply the content in their work.
3. Obtain rice seed and grow a small plot in the greenhouse or outside in a bed or field, depending on the situation. Analyze the local climate to determine the best approach in growing the specimen rice plants. In some areas, FFA or class projects may involve growing rice for market.

Evaluation: Evaluation should focus on the extent to which the students have achieved the objectives for the lesson. Strategies include:
1. Observation of student performance in class, especially as the review is being done.
2. Giving a written test (sample is attached).
3. Student performance on supervised agricultural experience, including ownership, placement, and directed laboratory.

Name_____

Test
Rice Production and Marketing

Unit II: Determining the Biology of Rice
Problem Area A: Determining the Characteristics of Rice

Instructions: Answer the following questions. Be sure to spell correctly.

1. What is the scientific name for Asian rice?

2. A _____ is a rice variety developed by scientists that is cultivated.

3. The two main classifications of rice by water requirements are _____ and _____.

4. A _____ is a stem structure that develops from a seedling rice plant.

5. The characteristics of rice kernels that allows light to pass through is known as _____.

6. When is a rice plant mature?

7. How does weather affect grain formation?

8. What are the general requirements for rice culture?

9. Why is rice said to be an annual marsh grass?

10. Sketch a rice plant and label the four major parts. (Use the back of this sheet.)

OBJECTIVES

Unit II: Determining the Biology of Rice

Problem Area A: Determining the Characteristics of Rice

Upon completion:

1. List the scientific name for rice.

2. Distinguish between rice and wild rice.

3. Describe the unique features of rice as a plant.

4. Explain the general requirements for the growth of rice plants.

SCIENTIFIC CLASSIFICATION OF RICE

Scientific classification - a system used to distinguish between and show relationships among living organisms.

Taxonomy - the science of classification.

Seven-stage system:

Kingdom
Phylum or Division
Class
Order
Family
Genus
Species

Variety - group of related plants within a species, with differences too small to be a different species.

Cultivar - cultivated variety developed by scientists for desired characteristics.

MAJOR SPECIES OF RICE

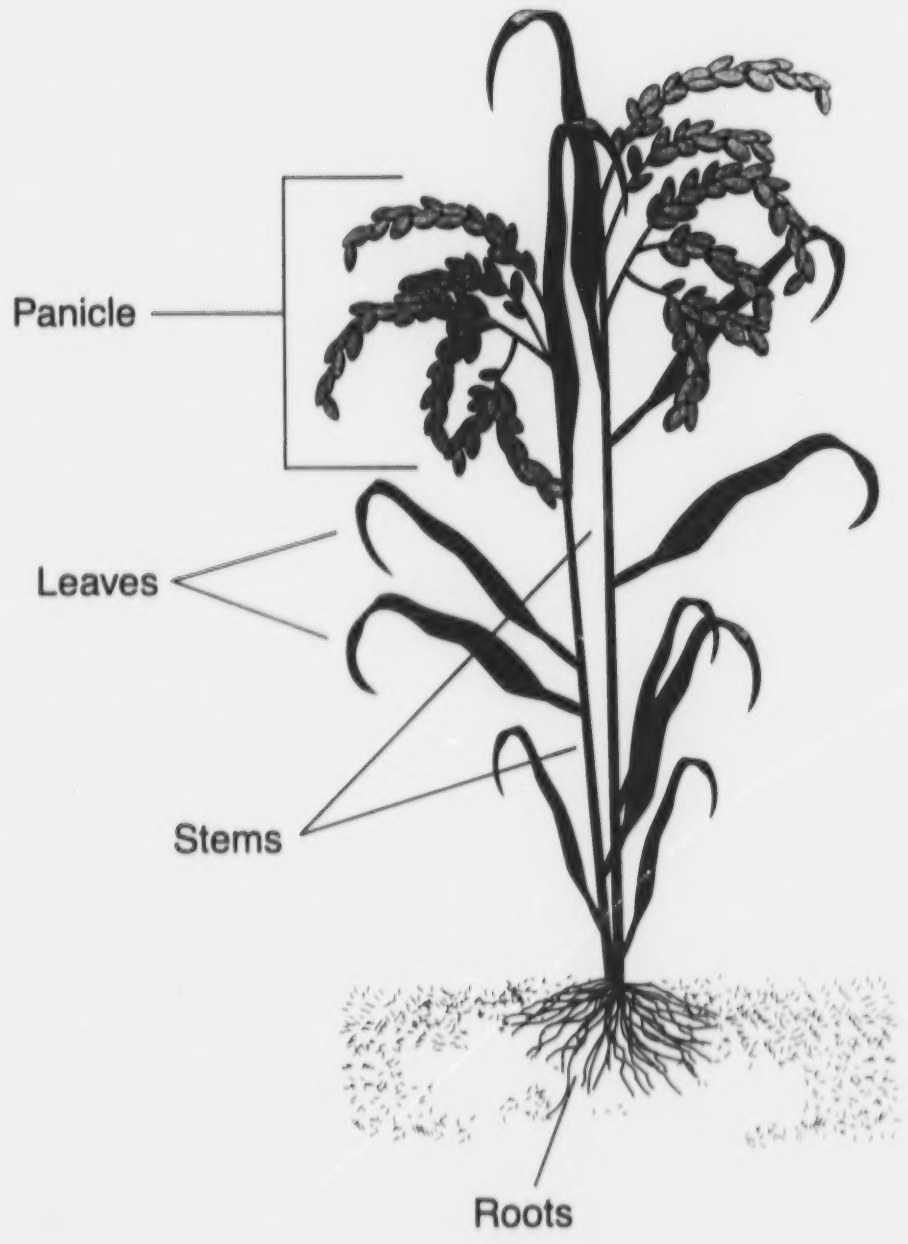
Asian rice - *Oryza sativa*

- Originated in Asia
- Dominant species grown worldwide

African rice - *Oryza glaberrima*

- Grown primarily in West Africa

MAJOR PARTS OF A RICE PLANTS



RICE CLASSES BASED ON WATER REQUIREMENTS

Paddy rice (also known as lowland rice) - grown in continuously flooded fields

- Careful irrigation practices are followed
- Water is removed for harvest

Upland rice - grown in fields without standing water

- Considerable moisture is required
- Yields are typically lower than paddy rice

CONDITIONS FOR RICE PLANT GROWTH

Light - full sun

Temperature - warm climate

Air - rice seed and seedlings have the unique ability to live and grow in the absence of free oxygen; after emergence from water, leaves take in carbon dioxide and oxygen

Water - carefully regulated on modern farms

Nutrients - requires high amounts of nitrogen; other nutrients are needed, including phosphorus and potassium; soil analysis needed before applying nutrients

Pest control/management - includes weeds, insects, diseases, birds, and others

Rice Production and Marketing

Unit II: Determining the Biology of Rice

Problem Area B: Determining the Structure of Rice Grain

Estimated Time: 1-2 hours

Purpose/Goal: The overall goal of this lesson is to help students understand the structure and importance of rice kernels.

Learning Objectives: Upon completing this problem area, students will:
1. Label the major parts of a rice grain.
2. Dissect a rice grain.

Instructional Resources: The following instructional resources are recommended for teaching this problem area:

Essential: Transparencies TRIIB-1, TRIIB-2, and TRIIB-3; handout HIIB-1; tweezers, scalpel, and rice grain (preferably an unpolished grain).

Additional: Access to the Internet and World Wide Web, particularly the following web site may be useful: http://www.cgiar.org/irri/riceweb/Plant.htm

Preparation: Use the following general strategy to introduce the problem area.

Begin preparing learners for the lesson by asking, "What is in a rice grain that makes it so important?" Answers from students may include starch, food, nutrients, fiber, and energy. Have students indicate if these are important in providing a proper diet for the people of the world.

Next, ask about how such a tiny grain could contain all of the benefits. Indicate that the purpose of this lesson is to explore the structure of a rice grain.

Caution: Be sure to instruct students in the safe use of equipment used in the dissection of grain.

Move from the interest approach into the objectives for the lesson. Write the objectives on the chalkboard or use transparency TRIIB-1. Afterward, begin the content of the first objective.

Presentation: Use the following summary of content and suggested teaching techniques to provide the instruction.

Summary of Content	Teaching Techniques
I. What are the major parts of a rice grain?	
A. The rice plant bears a cluster of flowers at its top.	A. Bring a specimen rice plant with mature grain to class or observe plants in a field.
1. The fruit formed following flowering is rice grain.	
2. The grain is harvested after maturity.	
-Newly harvested grain is known as rough rice or paddy rice.	
-Newly harvested grain has a golden-yellow color.	
3. Rice grains are covered with coarse hulls when first harvested.	3. Use TRIIB-2 or a sketch on the chalkboard to label the major parts of a rice grain.
-The hull has a stalk where the grain joined the rice plant stem and bristles on the end opposite the stalk.	-Have students examine rice grains as removed from a plant. Note the hulls, stalk, and bristles.
-Threshing is used to remove the hulls.	
-After threshing, rice is known as brown rice.	-Have students remove the hulls from rice grains with their fingers. Use a hand lens to observe the fine details of the bran structure.
B. Brown rice is milled resulting in a white grain.	

1. The outer brown cover is known as bran.

-Bran is high in vitamins and minerals.

-Bran is in three layers known as pericarp, testa, and aleurone.

-Bran protects the embryo and starchy endosperm.

2. Milling removes the embryo from the rice grain.

3. The product remaining after milling is starchy endosperm.

4. The bran removed from rice is primarily used as an ingredient in livestock feed.

1. Make a field trip to a hulling mill to study the mechanical processes in milling rice.

4. Ask students to read the label on feed to determine if rice bran has been used as an ingredient.

II. How is a rice grain dissected?

A. Dissection is used to observe the structure of a rice grain.

1. Dissection is cutting a grain and separating the parts for observation.

2. Because a rice grain is small, a hand lens will be needed to make good observations.

B. Safety is important in dissecting a rice grain.

1. Eye protection should be worn in case a tiny fragment breaks away and flies toward an eye.

B. Review safety precautions in dissecting a rice grain.

1. Provide each student with proper eye protection.

2. Care should be followed in using a scalpel to cut the grains.	2. Demonstrate how to hold and use a scalpel.
3. Grains should be held with tweezers and not with the fingers while being cut.	3. Demonstrate how to hold a rice grain with tweezers.
C. Because rice grains are small, dissection is a tedious process.	C. Use handout HIIB-1 or outline the procedure to use in dissecting a rice grain on the chalkboard. -Provide rice grains and the needed equipment for dissection. -Have students draw and label the parts of a rice grain that they observe.

Review: Use transparency TRIIB-3 or make a sketch on the chalkboard of a rice grain without the parts labeled. Call on students to label the various parts. Ask how the bran is used once it is removed from the rice grains.

Application: Two application suggestions are offered here:
1. Have students conduct library research on the milling of rice. Books as well as the Internet and World Wide Web may be used. Students may contact the International Rice Research Institute, P. O. Box 933, 1099 Manila, Philippines, or use the World Wide Web home page address: http://www.cgiar.org/irri
2. Students can apply knowledge of rice grains in supervised experience at mills, on farms, and in other ways.

Evaluation: Evaluation should focus on the extent to which the students have achieved the objectives for the lesson. Strategies include:
1. Observation of student performance in dissecting rice grains.
2. Giving a written test (sample is attached).
3. Student performance in supervised experience as related to the structure of rice grains.

Name_____

Test
Rice Production and Marketing

Unit II: Determining the Biology of Rice
Problem Area B: Determining the Structure of Rice Grain

Part I - Fill-in-the-Blank: Provide the information to complete the statements listed below. Be sure to spell correctly.

1. The fruit formed following flowering on a rice plant is known as _____.

2. Newly harvested rice is known as _____ rice or _____ rice.

3. _____ is used to remove the hulls from rice grain.

4. After threshing, the rice is known as _____ rice.

5. Milling results in a _____-colored rice grain.

6. The scientific name of the product remaining after milling is _____ _____.

7. The tool used to hold a rice grain for dissection is _____.

8. The best tool for safely cutting a rice grain is a _____.

Part II - Structure of a Rice Grain: Draw and label the major parts of a rice grain that has not been threshed.

Dissecting a Grain of Rice

Objective: Depict the shape and parts observed in a rice grain with a sketch.

Activity: Dissecting a Rice Grain

Materials Needed: Several grains of rough rice, tweezers, magnifying glass, scalpel, and a flat, smooth-surfaced container.

Steps: Observe the following steps:

1. Put on eye protection.

2. Select a large, plump grain of rough rice.

3. Using tweezers to hold the grain, cut off the hull with the scalpel. (Caution: Be careful in handling and using a scalpel. Never attempt to cut a rice grain while holding it in your hand.)

4. Compare what you observe with the transparency Rice Grain Composition (TRIIB-2) or the sketch your teacher has made on the chalkboard.

5. Sketch the grain you observe below. Record observations about the major parts, texture, color, and other characteristics on the sketch. Compare your observations with the rice grain shown in the transparency or the sketch your teacher has made on the chalkboard.

OBJECTIVES

Unit II: Determining the Biology of Rice

Problem Area B: Determining the Structure of Rice Grain

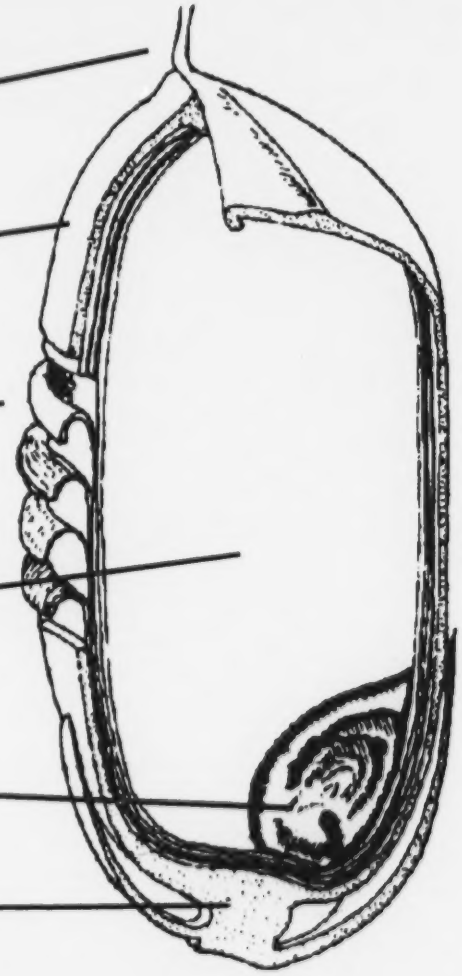
Upon completion:

1. Label the major parts of a rice grain.

2. Dissect a rice grain.

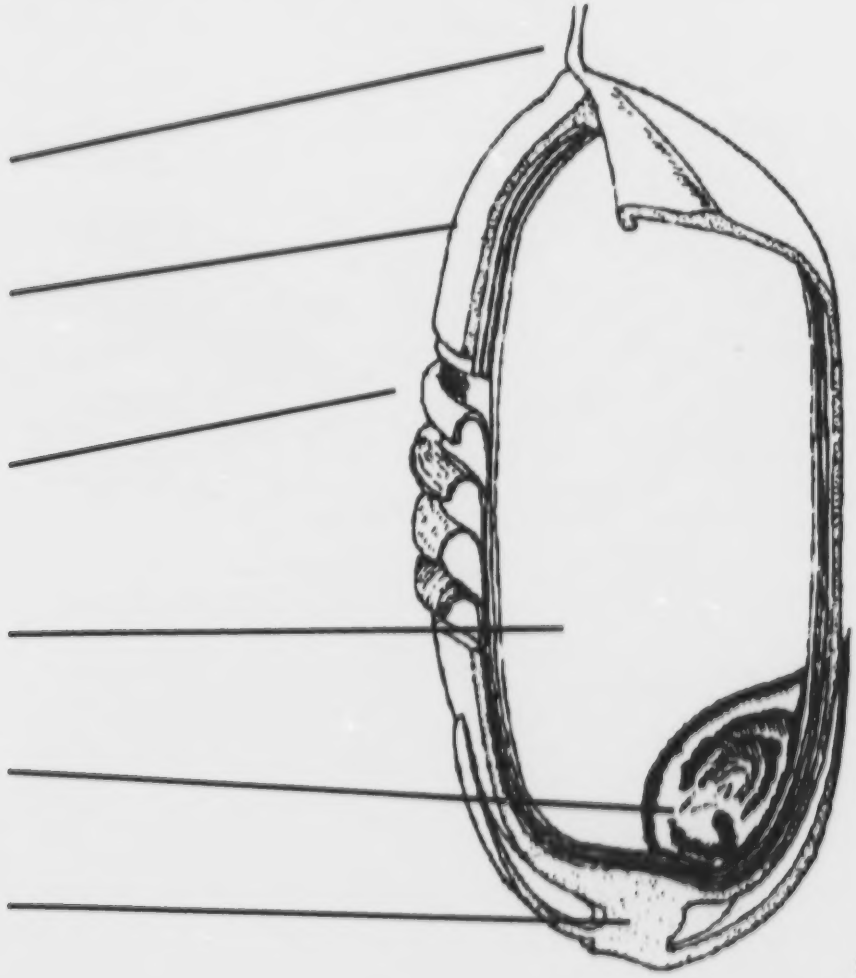
RICE GRAIN COMPOSITION

- Bristles
- Hull
- Bran Layers
- Starchy Endosperm
- Embryo
- Stalk



TRIIB-2

RICE GRAIN COMPOSITION



TRIIB-3

Unit III: Seeding Rice

Problem Area A: Preparing the Seedbed

Estimated Time: 2-3 hours

Purpose/Goal: This problem area is designed to teach the fundamentals of land grading and seedbed preparation.

Learning Objectives: Upon completing this problem area, students will:
1. List and explain the characteristics of land best suited for rice.
2. Describe land grading.
3. Explain seedbed preparation.

Instructional Resources: The following instructional resources are recommended for use in teaching this problem area:

Essential: Transparency TRIIIA-1; samples of soil for students to assess suitability for use in rice farming.

Additional: Any brochures, books, or other materials on rice preparation will be useful. Students may also use the Internet and the World Wide Web to locate information.

Preparation: Use the following general strategy as an interest approach to introduce this problem area:

Ask students to explain how land is prepared where crops are planted. Begin by asking what needs to be done to soil before seeds are planted. Call on one or more students to describe how they prepare flower beds or gardens for planting. Ask others to explain how large fields are prepared for planting crops. Ask them to name local crops and give examples of preparation activities. Further, ask students to explain why these activities are important in successfully producing a crop.

Summarize the interest approach by indicating that rice has unique seedbed preparation needs. The land must be prepared to manage water as well as other cultural practices.

Move from the interest approach into the objectives for the problem area (lesson). Use transparency TRIIIA-1 or the chalkboard to present the objectives. Ask different students in the class to read the objectives. Depending on teaching style, students should be instructed to write the objectives in their notebooks.

Presentation: Use the following summary of content and suggested teaching techniques to provide the instruction.

Summary of Content	Teaching Techniques
I. What are the characteristics of land that is best suited for rice production?	
A. Rice grows best on fine-textured, poorly drained soils.	A. Collect several soil samples from fields in the area for students to assess texture as related to rice production. (For information on soil texture, refer to pamphlets or textbooks such as *Introduction to Plant and Soil Science and Technology* and *Our Soils and Their Management*.)
1. Soils with impervious hardpans or claypans may be used for rice production.	
2. Soil content typically ranges from 25-70 percent clay.	
- Textural classes acceptable for rice include clay, silty clay, and silty clay loam soils.	
- Surface textural loam soil is acceptable if underlaid with a hardpan.	
3. The best soils for rice are those with low water permeability.	3. Have students demonstrate water holding capacity of soil by shaping a bowl from a soil sample high in clay. Pour a small amount of water into the bowl and observe what happens. Have students attempt the same with soil high in sand or organic matter. Discuss the results.
- This prevents water loss when it moves into lower strata of the soil.	
- Soils with good water-holding capacity (high clay content) are best.	
- Soils high in sand content have poor water-holding capacity.	

B. The land surface should be contoured and formed by grading.

1. This maintains a uniform water depth within the field (rice fields are known as basins or checks).

2. Large, laser guided equipment is used to move soil and create the desired contours.

B. Ask students to compare what happens to water on sloping land as compared to nearly level land.

1. Ask students how land forming helps control water. (It eliminates high places and low places in fields so that when a rice field is flooded the water is evenly dispersed over the surface.)

II. What is land grading?

A. Land grading is preparing a land surface that is best for rice.

1. Land grading shapes the land for modern cultural practices.

2. Formed land for rice is near level to 0.05 feet slope per 100 feet.

A. Take a field trip to observe land forming or have land forming equipment brought to the school.

2. Use a 100-foot tape measure and demonstrate the amount of slope in a 0.05 feet of slope per 100 feet. Have students calculate the amount of fall in 100 feet in inches (0.6 inch or slightly over ½ inch).

B. The major benefit from precision leveling is more efficient use of water.

1. A high percentage of all land in rice in the United States has been formed using laser-guided equipment.

2. A near level grade of no slope is used in fields that are only used for rice production.

C. Properly graded land has three advantages in addition to water use.

1. Formed land helps get a good rice plant population (number of rice plants).

1. Ask a student to explain the concept of plant population.

2. Formed land helps in controlling weeds.	2. Ask a student to explain how water is used to control weeds.
3. Formed land helps with drainage for harvest.	3. Ask a student to explain how formed land with a slight slope helps with draining prior to harvest.
C. Precision leveling to zero grade provides maximum control of water depth but may result in poor surface drainage and muddy soil conditions during harvest; therefore, some slight slope is desirable.	
D. Overly steep fields result in difficulty in controlling water depth.	
E. Precision leveling results in fewer levees.	
1. Fewer levees mean that more land is available for rice production.	1. Ask a student to explain how fewer levees give more land for rice production (less land is needed in levees).
2. Fewer levees mean lower costs in water management and levee maintenance.	
3. Fewer levees make more efficient use of larger machinery.	
F. Large earth-moving equipment guided by a laser system is needed to grade land.	F. Have students prepare a bulletin board on land-forming equipment. Photographs can be obtained from brochures used to advertise equipment.
1. Many rice producers use custom services to form the land.	
2. Only the largest growers can afford the investment costs of large earth-moving equipment and laser systems.	2. Interview a dealer to get information on the costs of land-forming equipment.

III. How is the rice seedbed prepared?

A. Seedbed is the top few inches of soil where rice seeds are planted.

1. It is used to create the best possible soil environment for planting seed and growing the rice crop.

2. The top few inches of soil should be loose but compact and be free of large clods.

A. Ask students to discuss preparing a seedbed in soil of the texture needed for rice production. (Soil high in clay is slow to dry and readily forms clods if plowed wet.)

B. Several steps are needed in seedbed preparation.

1. Straw remaining from the previous harvest is removed by raking, soil incorporation, and burning.

- Most fields produce more straw than can be properly incorporated into the soil.

- Raked straw may be baled or loaded unbaled and hauled from the field.

- Burning is becoming less desirable because of the smoke produced that pollutes the air.

2. Laser-guided scrapers or land planes may be used to remove high areas in the field and fill low areas that have developed since the previous year.

1. Ask students the use made of straw raked from a rice field. (Two examples are animal bedding and to cover sloping soil to prevent erosion.)

- Determine how farmers remove straw from rice fields in the local area.

3. Disks, harrows, and other types of primary tillage equipment are used to loosen the soil and break up clods.

4. Heavy corrugated rollers are used to break up clods and compact the seedbed.

4. Call on a student to explain why a seedbed needs to be compacted before planting.

- The rollers should travel in the direction that will give corrugated soil across the direction of prevailing winds.

- Corrugated packers give a more uniform seedbed than that left by harrows.

- Ask a student to explain the concept of corrugation (alternating high and low ridges).

5. Fertilizer and pesticide applicators may be attached to the corrugator.

5. Tour a farm, equipment dealer, or equipment show to observe how fertilizer and pesticide applicators are attached to corrugators.

- This allows growers to perform multiple seedbed preparation functions in one pass.

- Only fertilizer and pesticide needed should be used at the recommended rate.

Review: Ask different students to explain content associated with each of the objectives for the chapter. Call on one or more students to demonstrate that they have achieved each objective. Re-teach as necessary so that all students have achieved the objectives.

Application: Several application suggestions are offered here:
1. Have students prepare a seedbed for rice production in the school laboratory or in their supervised agricultural experience.
2. Have students study various land sites in the community suited to rice production. They should study the soil texture and slope of the land in preparing their recommendations on suitability of the land for rice farming.
3. Students can prepare a report on one or more areas of preparing the seedbed for rice. The reports can be written and/or oral.

Evaluation: Evaluation should focus on the extent to which the students have achieved the objectives. Strategies include:
1. Observation of student performance in all class activities as well as during the review of achievement of the objectives.
2. The proficiency of students who have supervised agricultural experience in rice farming can be observed as they go about establishing the seedbed.
3. Give a written test (sample is attached).

Name_____

Test
Preparing the Seedbed

Unit III: Seeding Rice
Problem Area A: Preparing the Seedbed

Instructions: Answer the following questions. Be sure to spell correctly.

1. What is the best soil for rice production?

2. What is water permeability in soil?

3. _____ _____ is shaping the land.

4. What is the best land slope for rice production?

5. What is the major benefit of precision land leveling in rice production?

6. In addition to the major benefit, what are three advantages of properly graded rice land?

7. What is the major disadvantage of forming rice land to zero grade?

8. What is a seedbed?

9. How is a rice seedbed prepared?

10. What are the major ways of removing straw from a rice field?

OBJECTIVES

Unit III: Seeding Rice

Problem Area A: Preparing the Seedbed

Upon completion:

1. List and explain the characteristics of land best suited for rice production.

2. Describe land grading.

3. Explain seedbed preparation.

BENEFITS OF LAND GRADING (LAND FORMING)

The major benefit of land grading is to allow more efficient use of water.

Other benefits of land grading are:

1. Stand establishment
2. Weed control
3. Field drainage for harvest

Unit III: Seeding Rice

Problem Area B: Planting Rice

Estimated Time: 1-2 hours

Purpose/Goal: This problem area is designed to help students develop abilities in planting rice seeds in a well prepared seedbed.

Learning Objectives: Upon completing this problem area, students will:
1. Explain the goal of planting.
2. List and describe methods of planting.
3. List the rate of seed planting.
4. Describe when seed are planted.

Instructional Resources: The following instructional resources are recommended for use in teaching this problem area:

Essential: Copies of transparencies TRIIIB-1, TRIIIB-2, AND TRIIIB-3.

Additional: Any brochures, books, or other materials with information on planting rice. The Internet and World Wide Web have web sites that may be useful.

Preparation: Use the following general strategy as an interest approach in preparing to teach the objectives of this problem area:

Ask students to review the structure of a rice plant. Have them explain the part that goes into the ground and the functions of the part. Ask students to explain how this is related to planting the seed properly. (Examples: roots grow in the soil and the plants are spaced apart so that all may have area to grow.)

Explain that this problem area/lesson covers planting rice. Move into the objectives. Use the chalkboard or transparency to present the objectives.

Presentation: Use the following summary of content and suggested teaching techniques to provide the instruction.

Summary	Teaching Techniques
I. What is the goal of planting?	
A. Planting is placing seeds in a good environment for their growth.	A. Ask students to explain planting in terms of bringing a viable seed into a good environment for germination.
1. The goal of planting is to uniformly disperse seeds throughout the field to achieve the desired plant population.	-Use transparency TRIIIB-2 or the chalkboard to outline planting concepts.
2. The seeds must be placed so that germination and growth are possible.	
B. Quality seeds of an adapted variety should be planted.	B. Use a sample of rice seed and conduct a rag doll seed germination test. (Place 25 seed on a damp paper towel, roll up the towel, and place in warm (75-80°F) for several days. Examine the rag dolls every two or three days for evidence of germination. After 10-12 days, determine the number of seed that have germinated and calculate a germination percentage.)
1. Planting poor quality seeds results in failure to have the desired uniform plant population.	
- Seeds should be free of weed seeds.	- Review the label on a seed container for purity and the presence of noxious weed seed.
- Seeds should be varietally pure. (Not have seeds of other rice varieties mixed in.)	
- Seeds should have high percent germination (about 90%).	
2. Planting a variety that is not suited may result in a poor crop yield and failure to meet the goal of planting.	

II. What are the methods of planting rice?	II. Use transparency TRIIIB-3 or the chalkboard to outline methods of planting.
A. Two main methods of planting are used: dry soil and flooded field.	
1. Seeds are planted in prepared, dry seedbeds using drills pulled by tractors or spread broadcast on top of the soil.	1. Have students attend a farm machinery show or visit a local equipment dealer to study the design of a grain drill and/or a broadcast spreader.
- Drills are carefully calibrated to place seeds in small furrows that are opened and closed by the equipment.	-Tour a farm that is planting rice. Determine the methods of planting used. Have students prepare oral or written reports on their observations.
- Broadcast spreaders disperse the seeds on top of the soil relatively uniformly over the field depending on the care of the tractor operator. (The seeds may be covered by light harrowing or left on top of the soil for flooding.)	
2. Aerial seeding involves using an airplane to disperse seeds uniformly over flooded or dry fields. (Those on dry fields are harrowed into the soil.)	2. Invite the operator of an airplane that is used to seed rice to serve as a resource person in class and describe how the plane is operated to obtain a uniform plant population.
3. Seeds are soaked or coated before planting in flooded fields.	3. Determine weight differences in soaked and dry samples of rice seeds. Weigh the samples before soaking and after soaking and draining to determine the weight gain due to water absorption.
- Soaking in water for 24-36 hours and draining for 18-24 hours before dropping into the flooded basin (field) helps assure a uniform plant population. (Unsoaked seeds will float on the water surface and distribute unevenly over the field by drifting on the top of the water.)	

- Soaking initiates germination and displaces air in the seed coat making the seeds heavier so they will sink through the water to the soil. (Soaking increases seed weight about 25 percent.)

- Planting soaked seeds shortens germination by about two days.

-Ask students to explain why soaking shortens germination period after planting.

- Once soaking and germination have begun, the seeds must be planted--no delay in planting is possible as the sprout will die.

- Seeds should be planted before the sprout (radicle) emerges (planting equipment will damage the sprout).

- Coating involves covering seeds with a sticking material to hold micronutrients and fungicide to protect germinating seed from damage. (The coating makes seed sink in the water.)

- Seedbeds under flooded fields should be left with clods or packed with a corrugated roller. (The clods and ridges left by a corrugated roller help prevent drifting by seed in the water and assure a more uniform stand. Corrugated rollers leave grooves 2 inches deep about 15 inches apart.)

- Ask a student to explain how clods or corrugations in the soil prevent seed drifting.

4. Aerial planting in dry fields involves broadcasting the seed over the land and harrowing the land to lightly cover the seed before flooding.

4. Visit a farm where an airplane is being used to plant rice seeds.

III. What rate of seeding is used?

A. Seeding rate refers to the quantity of seeds that should be planted to get the desired plant population.

1. The desired plant population is one which produces optimum yield.

- Optimum rice yields are obtained with 15-20 plants per square foot (653,400-871,200 per acre).

- Stands below 5-7 plants per square foot should be reseeded.

2. Seed weight varies with the method of planting.

- With drilling, 90-100 pounds of seed should be planted per acre.

- With aerial seeding, 120-150 pounds of seed (dry weight--before soaking) should be planted per acre.

A. Have students determine the number of seed in a pound. (Weigh an ounce of seed and count the number of seeds in the ounce. Multiply the number by 16 to determine the number of seed in a pound. If possible, have students compare long-grain with short- and medium-grain varieties.)

- Tour a rice field and determine the plant population. (Randomly select several square feet as samples. Project the average number in a square foot to an acre.)

B. Over seeding is needed to assure an adequate plant population.

1. Up to half or more of the seeds do not produce plants because of loss to birds, diseases, and other pests.

2. Seeding at the rate of 150 pounds per acre would result in 45-60 plants per square foot.

B. Ask students to explain over seeding. Have them name birds in the local area that feed on seeded rice fields.

IV. When are rice seed planted?

A. Date of planting depends more on air temperature than soil temperature.

1. Shallow water in fields warms quickly.

2. Warm water keeps the germinating seed warmer than the surrounding soil.

A. Have students determine the date when the air temperature in the local area typically reaches the minimum for planting rice. (Reports with weather information may be in the local library.)

B. The recommended temperature varies by region.

1. In California, the recommended minimum air temperature for planting rice is 70°F (21.1°C).

- Some growers wait until the water temperature in flooded fields is 70° F (21.1°C).

- Planting is possible between April 15 and June 1 under normal conditions.

2. In the Southeastern United States, rice can be planted at a somewhat lower air temperature of 65°F (18.3°C).

2. Obtain rice planting date recommendations from the Cooperative Extension Service at the land-grant university in your state.

- The temperature is reached earlier in the lower southeastern areas.

- Rice planting begins March 15 in southern areas of Louisiana and Texas and completed by May 15.

- Rice planting typically begins April 10 and lasts until June 5 in other areas of the Southeastern United States.

Review: Ask different students in the class to explain the content associated with each objective. Re-teach any areas needed to assure student mastery.

Application: Several suggestions are offered here to apply the content of the chapter:
1. If not during instruction, students can perform rag doll seed germination tests with samples of rice seed.
2. Have students calculate the number of seed in a pound of rice, the seeding rate to use at various percentages of germination, and additional seeding required to account for seed lost to birds at the recommended seeding rate for the local area.
3. Take a tour or have students individually visit a local rice farm and determine the plant population on selected fields.
4. Take air temperature measurements to determine when to plant rice in the local area. In some cases, the temperature of shallow areas of water can also be determined.

Evaluation: Evaluation should focus on the extent to which the students have achieved the objectives. Strategies include:
1. Observing student performance of the activities in class.
2. Observing student performance in their supervised agricultural experience as related to rice production.
3. Giving a written test (sample is attached).

Name_____

Test
Rice Production and Marketing

Unit III: Seeding Rice
Problem Area B: Planting Rice

Instructions: Answer the following questions. Be sure to spell correctly.

1. _____ is placing seed in a good environment for growth.

2. What is the goal of planting?

3. What are the two main methods of planting rice?

4. What is the difference in drilling and broadcasting seed?

5. Why and how are rice soaked for aerial seeding?

6. What is seeding rate?

7. What is the desired plant population in a rice field?

8. Why are rice over seeded?

9. What is the recommended temperature for planting rice? How is it determined?

10. How do the planting dates for rice vary between California and the Southeastern United States?

OBJECTIVES

Unit III: Seeding Rice

Problem Area B: Planting Rice

Upon completion:

1. Explain the goal of planting.
2. List and describe methods of planting.
3. List the rate of seed planting.
4. Describe when seed are planted.

PLANTING

Planting - Placing seeds in a good environment for their growth.

Goal - The goal of planting is to uniformly disperse seeds throughout the field to achieve the desired plant population.

Quality - Seeds should be:

1. Free of weed seeds and trash.

2. An adapted variety that are varietally pure.

3. Have a good gemination percentage.

METHODS OF PLANTING

Dry soil:

1. Tractor-powered:
   - Drills
   - Broadcast spreaders followed by harrowing

2. Airplanes followed by tractor harrowing

Flooded field:

1. Aerially with soaked seed

2. Aerially with coated seed

Unit IV: Culturing the Rice Crop

Problem Area A: Fertilizing

Estimated Time: 2-3 hours

Purpose/Goal: The overall purpose of the problem area is to develop students' abilities in meeting the nutrient needs of rice crops.

Learning Objectives: Upon completing this problem area, students will:

1. Explain the nutrient needs of rice.
2. Describe how fertilizers are used to provide nutrients.

Instructional Resources: The following instructional resources are recommended for use in teaching this problem area:

Essential: Copies of transparencies TRIVA-1, TRIVA-2, TRIVA-3, and TRIVA-4.

Additional: Any reference materials on rice production that is designed for use in the local area or on rice nutrient needs in general. Specific fertilizer recommendations would be useful. Soil sampling materials and analysis kits could be used to provide hands-on learning in sampling and testing.

Preparation: The following interest approach is a suggested strategy to prepare students for this problem area/lesson:

Have students compare their need for food with the need of rice plants for nutrients. Ask them to name different nutrients and sources in the human diet (examples: protein--meat; carbohydrates--potatoes; and vitamins--fruit). Students who have previously studied plant nutrition will be able to name examples of plant nutrients, such as nitrogen, phosphorus, and potassium. Ask students how plants use nutrients in growth and how deficiencies are manifested in plant leaf color and growth.

Move into the lesson by presenting the objectives using transparency TRIVA-1 or writing the objectives on the chalkboard.

Presentation: Use the following summary of content and suggested teaching techniques to provide the instruction.

Summary of Content	Teaching Techniques
I. What are the nutrient needs of rice?	
A. As a plant, rice requires nutrients similar to other plants.	
1. To grow, plants need light, temperature, water, and nutrients. - Light and temperature are environmental conditions that are not manipulated by the rice producer. - Water and nutrients can be supplemented to provide a good environment for the growth of a rice crop. 2. Research has shown that rice growth and yield can be enhanced by the proper application of needed nutrients unique to rice.	1. Carry out demonstrations with young rice seedlings in flats or flower pots that show the effects of deficiencies of various environmental factors needed for a plant to grow. (For example, one sample of rice seedlings can be placed in a dark room for several days. Other rice seedlings can be exposed to heat or cold, deprived of water, and grown with inadequate nutrients, such as nitrogen.) Carefully observe and record observations of the plants.
B. Nutrients may be classified as major nutrients and minor or trace elements.	
1. The three major elements most often needed in growing rice are nitrogen (N), phosphorus (P), and potassium (K).	1. Use transparency TRIVA-2 or write nitrogen, phosphorus, and potassium on the chalkboard. Ask students to provide the symbol for the element.

- The most limiting element is nitrogen, which is needed for lush green growth.

- Ask students to explain "lush, green appearance" as a result of using nitrogen fertilizer.

- Phosphorus and potassium are needed on soils with levels of the elements below the critical level.

2. The minor element that is most critical in rice production is zinc (Zn).

2. Write the word, zinc, on the chalkboard and ask a student to name the symbol for the element.

- Zinc deficiency can result in the failure of rice seedlings to grow or in extreme deficiencies, death of rice seedlings.

- Zinc deficiency is most damaging in the early part of the growing season when temperatures are cooler.

- Zinc deficiency is sometimes known as "alkali disease."

II. How are fertilizers used to provide nutrients?

A. Fertilizer is any material added to soil to provide nutrients plants need to grow and have high yields.

A. Use transparency TRIVA-3 or the chalkboard to define fertilizer and show how fertilizer needs are determined.

1. Fertilizer materials may provide one nutrient or a mixture of two or more nutrients.

2. The amount and kind of fertilizer needed can be determined by chemical analyses.

- Most frequently, soil samples are taken for analysis in the laboratory.

- Tissue from rice plants can be chemically analyzed to determine nutrient deficiencies, especially deficiencies of nitrogen, phosphorus, and potassium.

- Soil samples are usually taken before a crop is planted, while tissue analysis is from plant tissue after a crop is underway. (Tissue analysis indicates current nutrient deficiencies as well as helps project nutrient deficiencies for future cropping years.)

- Take a soil sample for a rice field or area of the school grounds using the proper collection procedures. Submit the sample to a laboratory for analysis or use a soil test kit to test the soil.

3. Fertilizer materials may be applied in solid particle, liquid, or gaseous forms.

3. Bring specimens of solid fertilizer materials to class.

B. The amount of fertilizer to apply varies with the kind of rice crop, plant population, and residual nutrients in the soil.

1. Rice typically requires 70-200 pounds of nitrogen per acre, with the higher rates needed for long-grain rice.

- Nitrogen may be applied before planting by soil incorporation or after the crop is growing, known as top dressing.

- Use transparency TRIVA-4 or the chalkboard to distinguish between soil incorporation and top dressing as times and methods of fertilizer application. (Soil incorporation is also known as pre-plant application.)

- Specific nitrogen requirements vary with soil type, cropping history on the land (soil recently planted to rice needs less nitrogen), planting date (early planted rice requires more nitrogen), and the amount of crop residue incorporated into the soil (decay of crop residue requires nitrogen).

- Ask students to explain how the decay process of straw ties up nitrogen in the soil (bacteria "tie up" the nitrogen in the decay process).

- Since rice is grown in a water environment, proper application of nitrogen is needed to get maximum use. (Place ammonium forms of nitrogen in the soil before planting and flooding.)

- Ask students to explain why ammonium forms are not as effective when placed in the water (rapidly undergo denitrification).

- The best sources of nitrogen for rice are aqueous ammonia, ammonium sulfate, and urea.

2. Incorporating 18-26 pounds of phosphorus (40-60 pounds of P_2O_5) before seedbeds are flooded improves rice yields.

2. Indicate that nitrogen is stated in elemental form while phosphorus and potassium are stated in compound forms (phosphorus is phosphate--P_2O_5 and potassium is potash--K_2O).

- Some soils have a build-up of phosphorus as a result of repeated use of phosphorous fertilizers.

- Top dressing can be used to apply phosphates but only early in the seedling stage of plant development.

- Ask a student to explain "top dressing."

3. Potassium is applied as potash (K_2O) based on soil analysis.

- The rate of application is 60-120 pounds per acre.

- Potash is incorporated into the soil prior to planting.

4. Fertilizer mixes combining nitrogen, phosphorus, and potassium are sometimes used.

4. Take a field trip to a fertilizer formulation plant. Determine the ingredients used in preparing mixed fertilizer.

5. Zinc is applied pre-flood at the rate of 2-16 pounds per acre of actual zinc.

- Rate of application depends on zinc deficiency.

- Zinc is available as zinc sulfate, zinc oxide, and zinc chelate.

- Zinc is not incorporated into the soil but is applied broadcast over the surface of the seedbed before planting (soil analyses will help determine the rate of application needed).

6. Some soils have an iron deficiency, which results in a disease of rice known as iron chlorosis.

6. Bring a leaf specimen that shows chlorosis to class (yellow streaks in the leaf). Ask students to note other plants that may have chlorosis and bring leaf samples to school.

- The application of iron gives inconsistent results.

- Since iron deficiency is related to free calcium carbonate in the soil and bicarbonate in irrigation water, lowering the pH usually takes care of iron deficiencies.

Review: Ask one or more students to summarize the content of each objective. This should result in a good review of the rice fertilization. Re-teach any need areas evident through review.

Application: Several activities to apply the content of this problem area/lesson are listed here:

1. Have students apply fertilization in supervised agricultural experience in rice production.
2. Arrange for students to collect soil samples for analysis. Follow the proper procedures in collecting the samples. Send the samples to a laboratory for analysis or use a soil testing kit to conduct the analysis.
3. Obtain the label from a fertilizer container and determine the analysis of the fertilizer ingredients. (Refer to other materials for assistance, such as *Introduction to World AgriScience and Technology*.)

Evaluation: Evaluation should focus on the extent to which students have achieved the objectives of the lesson. Strategies include:

1. Observing student performance throughout the problem area/lesson.
2. Noting student performance in collecting soil samples and otherwise handling samples and making analyses.
3. Giving a written test (sample is attached).

Name_____

Test
Rice Production and Marketing

Unit IV: Culturing the Rice Crop
Problem Area A: Fertilizing

Instructions: Answer the following questions. Be sure to spell correctly.

1. What are the four needs for plant growth?

1._____ 2._____

3._____ 4._____

2. What are the three major fertilizer elements needed in growing rice? (Write the name of the element and give its symbol.)

	Element	Symbol
1.	_____	_____
2.	_____	_____
3.	_____	_____

3. What minor element is most likely to be deficient in rice production? What are the signs of deficiencies of this element?

4. _____ is any material added to soil to provide nutrients needed by plants for growth.

5. What are the two kinds of laboratory analyses that may be done to determine the nutrients needed for rice production?

1._____ 2._____

6. Distinguish between these two times of fertilizer application:

soil incorporation_____

top dressing_____

OBJECTIVES

Unit IV: Culturing the Rice Crop

Problem Area A: Fertilizing

Upon completion:

1. Explain the nutrient needs of rice.

2. Describe how fertilizers are used to provide nutrients.

MAJOR ELEMENTS FOR RICE

nitrogen (N) - creates lush, rapidly-growing green plants

phosphorus (P) - used in plant growth processes and to store and transfer energy

potassium (K) - needed by plants for photosynthesis, moving sugar, and other functions

FERTILIZER

Fertilizer - any material used to provide nutrients for plant growth.

The amount and kind of fertilizer to use is determined by:

1. Soil analysis - chemical analysis of soil samples to determine nutrient deficiencies in the soil; done before planting.

2. Tissue analysis - chemical analysis of plant tissue samples to determine nutrient deficiencies in the plant; done as the plant is growing.

TIME OF FERTILIZER APPLICATION

Fertilizer may be applied to rice fields at two times:

Soil incorporation - applying fertilizer materials to land prior to seeding and flooding; the materials are typically harrowed into the soil.

Top dressing - applying fertilizer materials to rice fields after the flooding and the crop is growing; most benefit is when the plants are young.

Unit IV: Culturing the Rice Crop

Problem Area B: Controlling Pests

Estimated Time: 2-3 hours

Purpose/Goal: This problem is to help students understand the importance of controlling pests in rice.

Learning Objectives: Upon completing this problem area, students will:
1. Describe how pests cause losses in rice production.
2. Explain general methods of pest control.
3. Describe weed control in rice.
4. Describe disease control in rice.
5. Describe invertebrate pest control in rice.

Instructional Resources: The following instructional resources are recommended for use in teaching this problem area:

Essential: Transparencies of TRIVB-1, TRIVB-2, TRIVB-3, TRIVB-4, and TRIVB-5.

Additional: Any reference materials on pest control in rice. Bulletins giving recommendations for pest control in rice from the land-grant university or Cooperative Extension Service will be useful.

Preparation: Use the following general strategy to introduce this problem area:

Call on students to explain the meaning of "pest." Have them develop a definition of "pest" and list examples of pests in the local area. List the definitions and examples on the chalkboard.

An acceptable definition of "pest" is: anything that causes harm or loss. In some cases, the examples of pests may be those found in the home such as mice, roaches, and fleas. In other cases, the examples may be insects or snakes.

After a satisfactory definition has been developed and examples of pests listed, move into the objectives for the problem area. List the objectives on the chalkboard or use TRIVB-1.

Presentation: Use the following summary of content and suggested teaching techniques to provide the instruction.

Summary of Content	Teaching Techniques
I. How do pests cause losses in rice production?	
A. Pest damage affects the potential of making a profit from a rice crop.	A. Ask students to explain the meaning of profit--money remaining after all costs of rice production have been subtracted.
1. Damage varies with the kind of pest.	
2. The major kinds of pests are weeds, diseases, and invertebrates, including insects.	
B. Pests cause losses in several ways.	B. Use the chalkboard or TRIVB-2 to list and explain the ways pests cause losses in rice production. Ask students to give examples of each.
1. Damage plant parts--Leaves, stems, roots, and grain may be damaged. (Insects may eat holes in leaves or damage other parts of rice plants, including the grain.)	
2. Compete for space and nutrients--Growing pests, especially weeds, use nutrients intended for the rice crop. Large weeds take up space and may shade rice plants reducing rate of growth.	2. Ask a student to explain how pests compete for space and nutrients.
3. Reduce crop quality--Pests damage the quality of grain. The harvested grain may contain weed leaves, seeds, and broken stem parts.	

4. Increase production costs--Controlling pests costs money; therefore, the cost of growing a rice crop is increased by pests.

4. Call on a student to explain how pests increase the cost of growing rice.

5. Damage facilities--Some pests damage fields, levees, and other structures. (Crawfish burrow into the ground and levees.)

5. Ask a student to explain how facilities may be damaged, such as water loss.

II. What are the general methods of pest control?

A. Emphasis is on pest management because there is usually no sound way to completely control pests.

1. Integrated pest management (IPM) involves using methods that produce favorable consequences with minimal damage to the environment.

1. Write the definition of IPM on the chalkboard or use TRIVB-3.

2. Two major procedures are used with integrated pest management.

2. Use the chalkboard or TRIVB-3 to list and explain the two major procedures with IPM. If time permits, invite a rice farmer or a consultant who uses IPM to serve as a resource person and describe the use of IPM.

- Scouting--Scouting is determining the presence of damage and if it is likely to cause economic loss greater than the cost of control.

- Have students practice scouting a rice field.

- Control--Control is using methods to reduce the population of pests to a level that will provide the best economic returns.

B. Several practices are used to control pests in rice.

B. Use the chalkboard or TRIVB-3 to list and explain the general practices used to control pests in rice.

1. Chemicals (often called pesticides) can be applied.

1. Obtain the latest approved pest control information for the area.

2. The water level can be varied to control some pests, such as weeds.

2. Ask a student to explain how water level can be varied.

3. Drying fields after rice harvest to destroy pests that require water to survive.

3. Ask a student to explain how drying a field reduces certain pests. Have them name a kind of pest that would be controlled in this manner (aquatic weeds, for example).

4. Use rice seed that are free of diseases and weed seeds.

5. Plant rice varieties that resist pest problems.

5. Refer to information on recommended rice varieties to identify those that offer resistance to pest damage.

6. Rotating fields planted to rice with other crops helps control pests.

C. Most pest control strategies involve using a combination of control methods.

III. How are weeds controlled?

A. A weed is a plant that is growing where it is not wanted. (With rice, algae is sometimes included as a weed.)

A. Use the chalkboard or TRIVB-4 to present the definition of a weed. Ask students to name examples of weeds in the local area.

1. Weed problems ir rice may be from aquatic weeds or terrestrial weeds (knowing the kind of weed helps select a method of control).

1. Illustrate distinctions in aquatic and terrestrial plants, including weeds. Ask students to bring specimens of these weeds to class or take a field trip to locate these weeds.

- Aquatic plants grow in water.

- Terrestrial plants grow on the land.

2. Some weeds are submersed in the water; others grow above the surface.

B. Several weeds are problems in rice.

1. Annual grass weeds include: barnyardgrass (watergrass) (*Echniocholoa* spp.), sprangletop (*Leptochloa fascicularis*), and broadleaf signalgrass (*Brachiarin platyphylla*).

2. Annual sedges cause problems in rice, as follows: smallflower umbrellaplant (*Cyperus difformis*), ricefield bulrush (*Scirpus mucronatus*), and yellow nutsedge (*Cyprus esculentus*).

3. Annual broadleaf weeds include: redstem (*Ammannia* spp.), arrowhead (*Sagittaria montevidensis*), waterhyssop (*Bacopa* spp.), ducksalad (*Heteranthera limosa*), morningglory (*Ipomea* spp.), hemp sesbania (*Sesbania exaltata*), and smartweed (*Polygonuri* spp.).

4. Perennial broadleaf weeds are: Gregg's arrowhead (*Sagittaria longiloba*), river bulrush (*Scirpus fluviatilis*), and cattail (*Typha* spp.).

5. Two submersed (below the water) weeds that cause problems are: annual naiad (*Najas* spp.) and algae *chara* (*Chara* spp.).

6. Red rice (Oryza sativa) is a hard-to-control weed, with water depth and crop rotation most effective.

C. Control methods are based on the kind of weeds.

B. Obtain bulletins from the Cooperative Extension Service in your state that provides photographs of the common weeds. Use specimens of weed plants found in rice to help students with identification. Take a field trip to a rice farm to identify common weeds.

2. Ask a student to explain the difference in a grass, sedge, and broadleaf weed. (A sedge is a grass-like plant with three-cornered or round solid stems. Grasses have round hollow stems.)

3. Ask a student to distinguish between annual and perennial weeds.

5. Ask a student to explain the term, submersed (below the water surface).

1. Use only approved herbicides.	1. Review a bulletin that lists approved herbicides.
2. Combinations of methods are frequently used.	- Ask a student to explain the term, combinations of methods (using two or more methods at the same time).
- Flooding to a depth of 4-5 inches and the use of recommended herbicides will help control some weeds.	
- Increasing the water level in the rice field to a depth of 7-8 inches will control some weeds as the rice plants grow and the season progresses.	- Have students calculate the number of gallons of water required to have a water depth of 7 inches on an acre of land. (Note: One acre-inch is 27,155 gallons.)
- Other cultural practices and herbicides may be needed. (Use only recommended and approved herbicides.)	
IV. How are diseases controlled?	
A. A disease is an abnormal condition in a living rice plant.	A. Use the chalkboard or TRIVB-5 to define disease.
1. Causes of disease vary.	1. Use the chalkboard or TRIVB-5 to list the causes of disease.
-Diseases may be caused by living organisms, such as bacteria and fungi. (These are known as biotic diseases.)	
-Diseases may be caused by conditions in a rice plant's environment, such as weather, nutrient deficiencies, and pollution. (These are abiotic diseases.)	- Call on a student to explain how a nutrient deficiency results in disease in rice plants.
2. Diseases disrupt the normal growth of rice plants and reduce yields of grain.	

B. The major diseases of rice affect seedlings, stems, and grain.	B. Obtain copies of brochures about rice diseases that have been prepared for the local area.
1. Seedling diseases are caused by fungi that create molds, particularly molds in damp environments.	
- Molds are more likely in cooler weather when rice seeds are slower in germinating.	- Call on a student to explain why some diseases are more likely to develop in cool, damp weather (conditions are best for the growth of fungi and bacteria).
- Using good seed and planting a little later help prevent mold.	
- Increasing the rate of seeding can overcome some loss of seedlings.	
2. Stem rot and sheath spot are two diseases of rice caused by fungi that overwinter in infected crop residue or soil.	2. Examine rice plants that show evidence of disease. Have students identify the disease and specify an appropriate method of control.
- The fungi tend to cluster or aggregate in shapes that form structures known as sclerotia.	- View a sclerotia structure with a microscope. Identify the individual fungi to the extent possible. Have students sketch the structures observed on paper.
- The rice plants have black lesions on leaf sheaths at the level of the water with the centers of the spots being gray-green to straw colored. (The disease may move up the stem resulting in death of the leaf.)	
- Excess N fertilizer or plant over population can increase the risk of stem rot and sheath spot.	
3. Kernel smut is a disease in some areas, especially those with high humidity.	

V. How are invertebrates controlled?

A. An invertebrate is a small animal with a crusty shell-like covering or exoskeleton.

1. Some invertebrates attack the rice plants or grain, such as the rice water weevil and armyworm.

2. Some attack the fields and systems in which rice is grown, such as the crawfish.

B. Several invertebrates cause problems in rice, with insects being most common.

1. Rice water weevil (Lissoroptus *oryzophilus*)--The rice water weevil is the most damaging pest in some areas. The larvae stage feeds on the roots of rice plants. Symptoms include stunting, chlorosis, and leaf-feeding scars caused by adults. Control is with an approved insecticide.

2. Rice leafminer (*Hydrellia griseola*)-- The rice leafminer is a small olive-green fly that walks on the surface of the water. The larvae make tunnels in the leaves, known as mines. The mines are yellow at first and later become transparent. Control includes lowering the water level to reduce hatching of eggs. Planting rice varieties with erect leaves also reduces leafminers.

A. Use the chalkboard or TRIVB-6 to explain the meaning of invertebrate.

1. Ask students to explain how damage varies between attacks on plants and on fields and systems.

2. Use brochures about rice insects in the local area and specimens of insects to help students develop skills in insect identification.

- Have an entomologist or other person knowledgeable of rice insect pests serve as a resource person and discuss rice insect pest control.

- Bring samples of plants with rice leafminer damage to class. Have students observe the structures formed with a hand lens.

- Rice seed midge (Chironomdidae family)--Resembling small mosquitoes, midge larvae feed on seedlings, especially the developing embryo and root tips. Good water management helps reduce midge problems. Draining a field helps in control.

- Armyworm (*Pseudaletia unipuncta*) and western yellowstriped armyworm (*Spodoptera praefica*)--Armyworms are more likely to cause problems in the summer during rice stem elongation and grain formation. Larvae eat the leaves off of plants. With heavy infestations, rice yields are reduced. Use approved insecticides or allow natural predators to control armyworms.

- Observe the damage of armyworms to rice plants. Note the extent of the population of armyworms and how the worms attack leaves and stems.

- Tadpole shrimp (*Triops longicaudatus*)--These are tiny crustaceans that feed on and destroy rice seedlings. Planting a field quickly after flooding prevents tadpole shrimp problems. Use an approved pesticide to control tadpole shrimp.

- Examine a specimen of tadpole shrimp. Ask students to explain differences in this pest and the crawfish.

- Crawfish (*Procambarus clarki*)--Crawfish damage fields and levees by burrowing. This may disrupt irrigation and water management. Chimneys built by crawfish may interfere with harvest. Crawfish sometimes feed on rice grains and seedlings. Control may include allowing a field to be fallow (dry) a couple of years or using an approved pesticide. In some cases, the crawfish may be harvested.

- Explain that "crawfish" is sometimes spelled "crayfish." The crayfish spelling may be used more widely in other countries.

- Observe a crawfish chimney and burrow structure.

Review: Ask various students to explain the content of the lesson for each objective. Present the objectives using TRIVB-1 or by writing them on the chalkboard. Observing student performance in reviewing can also be used as an evaluation check and as the basis for needed re-teaching.

Application: Several application suggestions are offered here:
1. Students can apply integrated approaches with biology classes. This is especially useful in defining insects, crustaceans, and other terms. Distinctions among organisms that are pests can be related to biology class.
2. Have students prepare a poster or bulletin board on the pests of rice. Students can work individually or as teams on these projects. Some students can focus on weeds while others prepare materials on diseases, insects, or other pests.
3. Have students who are involved with rice production apply the content of the lesson in their work.

Evaluation: Evaluation should focus on the extent to which the objectives have been achieved by the students. Strategies include:
1. Observing student performance in class or in their supervised experience.
2. Giving a written test (sample is attached).

Name_____

Test
Rice Production and Marketing

Unit IV: Culturing the Rice Crop
Problem Area B: Controlling Pests

Instructions: Answer the following questions. Be sure to spell correctly.

1. How does pest damage reduce profit from rice production?

2. What are the ways pests cause losses with rice production?

3. What is IPM? What are the two major procedures with IPM?

4. What general practices are used in controlling rice pests?

5. How are weeds controlled in rice?

6. What are the disease problems of rice? How are they controlled?

7. What invertebrates cause problems in rice? How are they controlled?

8. What life forms of insects typically damage rice?

OBJECTIVES

Unit IV: Culturing the Rice Crop

Problem Area B: Controlling Pests

Upon Completion:

1. Describe how pests cause losses in rice production.

2. Explain general methods of pest control.

3. Describe weed control in rice.

4. Describe disease control in rice.

5. Describe invertebrate pest control in rice.

HOW RICE PESTS CAUSE LOSSES

1. Damage plant parts
2. Compete for space and nutrients
3. Reduce crop quality
4. Increase production costs
5. Damage facilities

INTEGRATED PEST MANAGEMENT (IPM)

IPM - Using methods that produce favorable outcomes with minimal damage to the environment.

Major procedures:

1. Scouting

2. Controlling

General practices in rice pest control:

1. Applying chemicals

2. Managing water level

3. Drying fields

4. Using pure seed

5. Selecting pest resistant rice varieties

6. Rotating fields planted to rice

RICE WEEDS

Weed - a plant that is growing where it is not wanted. Examples of rice weeds:

Annual grasses (Barnyardgrass, Sprangletop, and Broadleaf Signalgrass)

Annual sedges (Smallflower Umbrellaplant, Ricefield Bulrush, and Yellow Nutsedge)

Annual broadleaf weeds (Redstem, Arrowhead, Waterhyssop, Ducksalad, Morningglory, Hemp Sesbania, and Smartweed)

Perennial broadleaf weeds (Gregg's Arrowhead, River Bulrush, and Cattail)

Submersed weeds (Annual Naiad and Chara)

Control methods:

Applying approved herbicides
Using rice seed free of weed seed
Combinations, including water management

RICE DISEASES

Disease - An abnormal condition in a living rice plant.

Causes:

Biotic - caused by living organisms, such as bacteria and fungi

Abiotic - caused by conditions in the environment of a rice plant, such as weather, nutrient deficiencies, and pollution

INVERTEBRATES

Invertebrate - A small animal with a crusty shell-like covering known as an exoskeleton

Examples:

Insects -
- rice water weevil
- rice leafminer
- armyworm

Crustaceans -
- tadpole shrimp
- crawfish

Unit IV: Culturing the Rice Crop

Problem Area C: Managing Water

Estimated Time: 3 hours

Purpose/Goal: This problem area is to help students understand the importance and approaches used in managing water.

Learning Objectives: Upon completing this problem area, the students will:
1. Describe the importance of water management in rice production.
2. List sources of water for rice.
3. Name ways water is lost.

Instructional Resources: The following instructional resources are recommended for use in teaching this problem area:

Essential: Transparencies TRIVC-1, TRIVC-2, and TRIVC-3.

Additional: Information about rice water management in the local area.

Preparation: Use the following general strategy to introduce this problem area:

Ask a student to explain what happens to a plant when it does not have enough water. List the responses on the chalkboard or transparency. Expected responses include wilting and dying. Low water also reduces yields of the crop and increases certain pest problems. Ask a student to describe what they have observed in managing water in rice fields.

Explain that a deficiency of water for only a short time can reduce yields. Rice plants may be stressed or pests may gain an advantage. Have students name examples of places where they have seen crops stressed by lack of water. (If time permits, demonstrate the effect of inadequate water on a young plant growing in a container in the school laboratory.)

After general discussion of water management, move into the objectives for the problem area. List the objectives on the chalkboard or use transparency TRIVC-1.

Presentation: Use the following summary of content and suggested teaching techniques to provide the instruction.

Summary of Content	Teaching Techniques
I. What is the importance of water management in rice production?	
A. High yields of rice crops require careful attention to water management.	A. Ask students to tell why they think water management is important in rice production. (The examples listed should be used to build the answer to the question.)
1. Rice is unique because it is grown in flooded fields.	
2. Flooding occurs before or just after seeds are planted.	
3. The field is kept flooded throughout the growing season.	
4. Water is typically measured in acre-inches or acre-feet.	4. Use TRIVC-2 or the chalkboard to explain how water is measured. Ask a student to use a ruler to show the depth of an acre-foot and acre-inch. (1 acre-inch = 27,155 gallons)
- An acre-inch is an acre of land covered with water 1 inch deep.	- Show how to calculate the number of gallons of water in various depths. (A field with 3 acre-inches is 3 X 27,155 = 81,465 gallons.)
- An acre-foot is an acre of land covered with water 1 foot (12 inches) deep.	
5. Rice production typically requires 4.5-7.5 acre-feet of water.	- Have students make water requirement calculations based on acre-inches and gallons.
- The amount varies based on water loss.	
- As some water is lost, more water is added to the field to maintain the desired level.	- Have students calculate the number of gallons of water needed for rice if 4.5-7.5 acre-feet are used? (Note: First, convert to acre-inches, with 1 acre-foot equal to 12 acre-inches.)

B. Fields must be designed properly for good water management.	(Note: Unit IIIA-Preparing the Seedbed should be taught before this section.)
1. Fields should be formed so that water is flowed into the part of the field with the highest elevation.	1. Ask a student to explain the meaning of "land forming" and why it is important with rice.
2. Water slowly moves through the rice field toward the lowest elevation.	2. Take a field trip to a rice farm to see irrigation underway. Ask students to evaluate what they see and explain how they might go about improving it.
3. A system of levees and water control structures (rice boxes or weirs) is used to control flow and water depth.	
C. Irrigation is the use of water to encourage plant growth and production.	
1. With irrigation, water is artificially applied to the field.	1. Ask a student to define irrigation. Write the term and definition on the chalkboard.
2. Water management is more than irrigation.	
- Water management is following practices that make good use of natural and artificial sources of water for rice crops.	- Ask a student to explain how water management is more than irrigation--using practices that make efficient use of available water.
- Water management includes applying the right amount of water at the best time.	
D. Good water management is needed to make the most efficient use of the available water.	
1. The goal of early season water management is to establish a healthy, rapid-growing, and weed-free rice crop.	1. Ask a student to explain why early season water management is important.

- Shallow water (1-2 inches deep) encourages rice growth and root development.

- Shallow water favors weed growth.

2. Mid-season water management is to promote rice plant growth and inhibit weed growth.

2. Ask a student to explain the kind of growth desired in mid-season with rice plants.

- Deeper water (7-8 inches deep) delays early growth as well as deters weed growth.

- A continuous flood of 4-5 inches generally provides the best conditions.

3. Late season water management involves removing water from the field beginning about 5 weeks before harvest.

- Knowing when to begin lowering the water level comes with experience.

- Lowering the water level too early can result in grains that are not fully developed.

- Lowering too late leaves fields wet at harvest time creating problems for large equipment.

- Ask a student to explain what happens when equipment is used on wet land--bogs and makes ruts.

II. What are the sources of water for rice?

A. Water for rice is obtained from two major sources: surface and ground.

1. Surface water is from reservoirs (and sometimes streams) where it has been collected and stored.

- The major sources of surface water are melting snow, rainfall, and springs.

- Various systems of canals and pipes are used to convey water from reservoirs.

- Surface water may contain residues of substances from the area where it has collected.

2. Ground water is obtained from aquifers deep inside the earth.

- Wells are bored into the aquifers.

- Pumps lift the water through pipes to the earth's surface.

- Ground water is more expensive to obtain but is usually free of pollution.

B. Irrigation water should always be tested to determine its suitability.

1. Water may contain salt and other substances that harm land.

2. Water may transmit pests as it is moved from reservoirs to fields. (Ground water has few pests.)

A. Call on students to name sources of irrigation water in the local area, including the names of reservoirs or streams that are used.

- Invite a resource person from a water management district to discuss the procedures used in allowing the use of water for irrigation. (In dry areas, this may include how water is allocated to users.)

- Collect a sample of water from a reservoir and conduct simple tests using a test kit. Based on the findings from the test, have students assess the suitability of the water for irrigating rice.

- Tour a farm that uses ground water for irrigation. Note the kinds of equipment used to move the water to the rice fields.

1. Ask a student to explain the effects of salt on most growing plants--injury or death.

III. How is water lost from rice fields?

A. Water loss is expensive and increases the cost of rice production.

A. Ask a student to explain why water loss is expensive.

1. Moving water to a field requires facilities that do not leak and that operate efficiently.

2. If losses can be reduced, rice can be grown more economically.

B. Water is lost in several ways.

B. Use TRIVC-3 or the chalkboard to list ways water is lost.

1. Percolation in the soil results in the loss of water.

1. Ask a student to explain percolation as a source of water loss. Also, have a student explain why water loss is greater in sandy soils.

- Sandy soil allows water to percolate downward away from the roots of rice plants and the surface of the field.

- Soils with more clay hold water and reduce downward percolation.

2. Evaporation results in water being lost into the air.

2. Ask a student to explain the process of evaporation.

- Water molecules move into the air as vapor from the surface of the water in rice fields.

- Higher air temperature and lower humidity generally result in more evaporation.

3. Transpiration is evaporation that occurs from the leaves of rice plants.

3. Use a microscope to view the stomata on the leaves of rice plants.

- Tiny openings in leaves known as stomata allow water to go into the air.

- Weather conditions that promote transpiration are sun radiation, wind, temperature, and humidity.

- Growers cannot control the weather and must apply water accordingly.

- Ask a student to explain the effect of sunlight on water evaporation.

C. Water loss has been studied to identify ways of preventing loss.

1. Evaporation and transpiration losses are combined as evapotranspiration.

1. Explain the concept of evaporation as a combination of evaporation and transpiration.

- Typically, 3-3.5 acre-feet of water may be lost from rice fields by evapotranspiration.

- Have a student use a tape measure and indicate how deep the amount of water lost by evapotranspiration.

- Evaporation is less in humid climates and during precipitation.

- Have students calculate the number of gallons of water lost by typical evapotranspiration.

2. Soil percolation accounts for much less water loss than evapotranspiration except in very sandy soils.

- In most rice fields, 0.5-2.0 acre-feet of water are lost due to deep percolation.

- Even though the water may be lost from the surface, it will aid in replenishing the ground water supply.

- Ask a student to explain how water lost to percolation may help replenish the ground water supply.

3. Some small amount of water may flow through a rice field system.

- Flow through should be kept to a minimum because it represents excess application of irrigation water.

- Flow through water may contribute to water flow in nearby streams. (This source of water is important in some streams.)

- Ask a student to explain how flow through water may be a sign of excessive irrigation.

Review: Take each objective separately and call on students to demonstrate that they have mastered the objective. Use TRIVC-1 or the chalkboard to present the objectives.

Application: Several application suggestions are offered here:
1. Have students calculate the volume of water needed for 50 acres of rice for 3 acre-inches of water. How long would be required for a pump producing 5,000 gallons per minute to provide the water? (Assume no loss by evapotranspiration and percolation.) Use other acreages, water depths, and rates of pumping to enhance the mathematics applications of this problem area.
2. Have students prepare an estimated cost of establishing an irrigation system for a rice farm. They should research the fixed costs of pumps, canals, pipes, wells, and other inputs used for a farm. A summary of all equipment and costs should be developed. Information can be collected from rice farmers, suppliers of equipment, well boring companies, and others.
3. Students who are involved with rice production should apply the content of this lesson in producing their rice crops.

Evaluation: Evaluation should focus on the extent to which the objectives have been achieved by the students. Strategies include:
1. Observing student performance throughout the lesson, including application activities.
2. Giving a written test (sample is attached).

Name_____

Test
Rice Production and Marketing

Unit IV: Culturing the Rice Crop
Problem Area C: Managing Water

Instructions: Answer the following questions. Be sure to spell correctly.

1. What is an acre-inch of water?

2. How many gallons of water are in 2 acre-inches of water? _____
(1 acre-inch = 27,155 gallons)

3. How many acre-feet of water are typically required for rice production?_____

4. What is irrigation?

5. How does water management differ from irrigation?

6. What are the goals of water management at the following times:

Early season

Mid-season

Late season

7. What are the two major sources of water for rice?_____ _____

8. What are the ways water is lost in a rice field?

9. What is evapotranspiration?

10. How is water percolation related to soil type?

OBJECTIVES

Unit IV: Culturing the Rice Crop

Problem Area C: Managing Water

Upon Completion:

1. Describe the importance of water management in rice production.

2. List sources of water for rice.

3. Name ways water is lost.

HOW IRRIGATION WATER IS MEASURED

Irrigation water is measured as:

acre-inches - an acre-inch is 1 acre covered with 1 inch of water

acre-feet - an acre-foot is 1 acre covered with 1 foot of water

1 acre-inch = 27,155 gallons

Water requirement in acre-inches is found by multiplying number of acres by inches of water depth.

WAYS IRRIGATION WATER IS LOST

Percolation - downward movement of water in the soil; greatest in sandy-type soil and lowest in clay-type soil

Evaporation - water lost by molecules moving into the air as vapor

Transpiration - water lost through stomata of plant leaves

Evapotranspiration - combination of evaporation and transpiration

Unit V: Harvesting and Post-Harvest Management

Problem Area A: Harvesting

Estimated Time: 2 hours

Purpose/Goal: This problem area helps students understand the importance of harvesting in achieving a profitable rice production enterprise.

Learning Objectives: Upon completing this problem area, students will:
1. Describe harvesting.
2. Explain when rice is harvested.

Instructional Resources: The following instructional resources are recommended for use in teaching this problem area:

Essential: Transparency TRVA-1 and handout HVA-1. The apparatus and supplies to determine the moisture content of a rice sample are needed.

Additional: Any reference materials on harvesting rice will be beneficial. Bulletins from the Cooperative Extension Service on rice harvesting will help localize harvesting methods.

Preparation: Use the following general strategy to introduce this problem area:

Ask students to explain the meaning of harvesting. They may offer several suggestions such as "gathering the rice grains" or "running a combine through a field." Next, ask why harvesting is important. Student responses should focus on efficiency in harvesting, such as collecting the grains from rice plants with little loss.

Move into the problem area by presenting the objectives for the problem area using TRVA-1 or listing the objectives on the chalkboard.

Presentation: Use the following summary of content and suggested teaching techniques to provide the instruction.

Summary of Content	Teaching Techniques
I. What is harvesting?	
A. Harvesting is collecting the kernels from the rice plants with a minimum of loss and damage.	A. Have a sample of harvested rice kernels in class. Have students assess the sample for broken grains, immature grains, and other imperfections.
1. Rice is more difficult to harvest than other grain crops.	
- The kernel resists separation from the panicle.	
- Equipment specially designed or modified to harvest rice should be used.	
2. Self-propelled rice combines are used in harvesting.	2. Take a field trip to a farm or equipment dealer to observe a rice combine. Compare the features with combines used for wheat, grain sorghum, or other crops.
- These combines differ from those used to harvest other grains, such as wheat or sorghum.	
- Rice combines may have large tires or tracks to prevent rutting and help the equipment move over wet soil.	
- The cylinder in the thrashing part of the combine is fitted with spikes to increase the thrashing action to separate kernels from panicles.	- Compare the cylinders on rice combines with other combines. Look at the cylinder for spikes.

B. Maintaining grain quality is important.

1. Cracks in rice kernels reduce the value of the rice.

1. Use a hand lens to observe cracked kernels. Calculate the percentage of cracked kernels in a sample of rice.

2. Tests to determine kernel moisture content may be used.

C. Once removed from the plant and held in the combine, the kernels are loaded into wagons or trucks for hauling.

C. Take a field trip to a farm during rice harvest. Study the procedures used in harvesting and to move the rice for storing.

1. Harvested grain may be stored on the farm or in commercial elevators.

2. Harvested grain is artificially dried to reduce the moisture level so that the rice does not deteriorate while in storage.

D. Operators of harvest equipment should be trained and experienced in how to operate the equipment for an efficient harvest.

D. Interview a combine operator to determine the important skills in efficiently harvesting rice.

II. When is rice harvested?

A. Rice is harvested based on several factors.

1. Moisture content of the kernels may be the most important factor in determining when to harvest rice.

1. Determine the moisture content of a sample of rice kernels. Use an electronic moisture tester, air oven, or other method. Give each student a copy of handout HVA-1. Demonstrate the procedure and allow each student or pairs of students to dry samples of rice.

- Short- and medium-grain varieties are harvested at 20-24 percent moisture.

- Long-grain varieties are harvested at 18-20 percent moisture.	- Compare the moisture content of long-, medium-, and short-grain rice.
2. Maturity is an important factor.	
- Rice kernels should be fully developed; therefore, do not harvest too early.	- Examine immature rice kernels. Have students describe the appearance and compare immature kernels to mature kernels.
- Rice kernels should not dry too much in the field as this results in cracking and "sun checks."	
- The price paid for cracked kernels is discounted.	
3. Rice is harvested based on field dryness.	3. Ask a rice producer to explain the procedures followed in draining and drying fields prior to harvest.
- Water draw-down should be started 10-15 days before harvest.	
- Loamy or sandy soils should be drained about 10 days before harvest.	
- Clay soils should be drained about 15 days before harvest.	
- Drainage dates are 20-25 days after heading.	
B. Harvesting equipment should be available at the time needed.	
1. Custom harvesters should be scheduled based on the crop maturity.	
2. Equipment should be field worthy by harvest time so that harvest can proceed without breakdowns.	2. Get a local combine operator or equipment dealer to explain maintenance to prepare a combine for the harvest season.

Review: Have students summarize the content of each objective orally in class. Use transparency TRVA-1 or the chalkboard to present the objectives. Observation of student performance throughout the lesson can provide useful information for reviewing.

Application: Several application suggestions are offered here:
1. Students with supervised agricultural experience on rice farms should use testing equipment to become familiar with methods of testing moisture content. This information will be used in determining when to harvest, as well as how much artificial drying is needed for harvested kernels.
2. Scout a field for lost kernels. These are rice grains that the combine did not harvest. In some cases, moving equipment might have knocked them off of the plant. In other cases, improper equipment adjustment might have failed to separate the kernel from the panicle. Count the number of kernels in a square foot. Use arithmetic methods to project this quantity to the entire field.

Evaluation: Evaluation should focus on the extent to which the students have achieved the objectives. Strategies include:
1. Observation of student performance throughout the lesson and during the review.
2. Giving a written test (sample is attached).
3. Observing the performance of students in their supervised experience.

Name_____

Test
Rice Production and Marketing

Unit V: Harvesting and Post-Harvest Management
Problem Area A: Harvesting

Instructions: Answer the following questions. Be sure to spell correctly.

1. What is harvesting?

2. What equipment is used to harvest rice? How does it differ from equipment for harvesting other grains?

3. Why is kernel quality important?

4. What three factors determine when rice is harvested?

5. How does the number of days allowed for fields to dry vary with soil type?

6. What two steps can be taken to assure that harvesting equipment will be available when it is needed?

Activity

Determining Rice Moisture Content Using the Oil Immersion Method

This activity is to determine the percentage of moisture in a sample of rice. The overall procedure involves placing the rice sample in vegetable oil and heating the oil to 190°C to drive out the moisture. The oil and rice are weighed before heating and after heating. Differences in weight are due to moisture loss. Caution: This activity involves high temperatures. Follow proper safety procedures.

Materials Needed:

1 laboratory thermometer with capacity of 250°C
1 balance or scale capable of weighing to 0.1 gram
1 tall glass or metal heat-resistant container large enough to hold 100 grams of rough rice
1 pair of pliers or forceps
1 burner, stove, or other heating device
100 ml of vegetable cooking oil
4-5 pounds of rough rice (100 grams of rice will be needed per test)

Procedure:

Steps	Key Points
1. Weigh sample of rough rice.	a. Use properly sampled rough rice that has not been dried. b. Mix sample before weighing. c. Weigh 100 grams of rice.
2. Place rice in container.	a. Use a tall container so that it is easier to cover the bulb of the thermometer. b. Place small-meshed wire over the kernels to hold them in the oil.
3. Pour oil into container.	a. Any available cooking oil with no trace of water. b. Use only enough oil to cover the kernels. (Too much oil will prolong heating time.)

(Continued)

4. Install thermometer	a. Place a wire over the mouth of the container to hold the thermometer in place. b. Make sure that the kernels cover the thermometer bulb.
5. Weigh the entire apparatus (container, oil, kernels, thermometer, etc.) to determine the initial weight.	a. Use the same balance as in step 1. b. Record the weight in grams_____.
6. Heat the entire apparatus.	a. Watch the thermometer closely. b. With pliers or forceps, remove the apparatus from the heat immediately when the temperature reaches 190°C.
7. Weigh the entire apparatus again to determine the final weight.	a. Use the same balance as in step 1. b. Record the weight in grams_____.
8. Calculate moisture content of the kernels: Weight lost between the initial weighing and final weighing is the amount of moisture in the sample.	a. Initial weight minus final weight equals moisture content percent. _____ - _____ = _____% b. The result is more reliable if at least two determinations are made.

OBJECTIVES

Unit V: Harvesting and Post-Harvest Management

Problem Area A: Harvesting

Upon completion:

1. Describe harvesting.

2. Explain when rice is harvested.

Unit V: Harvesting and Post-Harvest Management

Problem Area B: Post-Harvest Management

Estimated Time: 2 hours

Purpose/Goal: This problem area helps students in properly managing rice following harvest.

Learning Objectives: Upon completing this problem area, students will:
1. Explain the meaning of post-harvest management.
2. Describe the proper storage of rice.
3. Describe how rice is dried.

Instructional Resources: The following instructional resources are recommended for use in teaching this problem area:

Essential: Transparencies TRVB-1

Additional: Any materials that deal with storing, transporting, and drying rice would be useful.

Preparation: Use the following general strategy to introduce this problem area:

Ask students to name what is involved in producing a good rice crop. They will likely name soil preparation, planting, irrigation, pest control, and harvesting. Use this brief review to begin stressing the importance of post-harvest management. Ask the question, "What can happen after harvest to rice?" Students may name spills, getting wet, and pest contamination. How do these affect the value of the rice? Students may suggest that these cause losses and lower the value of rice.

Conclude the discussion in the interest approach by indicating that a top yield is of little benefit if it is lost or quality is reduced after being harvested, but before marketing. Use a mathematics example: Have students calculate the total dollars lost if quality is reduced so that the price is discounted 10 cents per bushel. Use examples of farmers with 10,000 bushels and 76,000 bushels. Multiply the amount per bushel (10 cents) by the number of bushels. The farmer with 10,000 bushels would lose $1,000, while the one with 76,000 bushels would lose $7,600! Good post-harvest management can prevent these losses.

Move into the problem area by presenting the objectives using TRVB-1 or the chalkboard.

Presentation: Use the following summary of content and suggested teaching techniques to provide the instruction.

Summary of Content	Teaching Techniques
I. What is post-harvest management?	
A. Post-harvest management is handling rice after it has been harvested to assure high quality grain when it reaches the market.	A. Write the words "post-harvest" on the chalkboard. Ask a student to explain the concepts that are involved. Use transparency TRVB-2 or the chalkboard to provide a definition.
1. Losses and damage to the grain rob the producer of income.	
2. Major sources of loss can be prevented.	
B. Sources of loss in harvested rice include contamination, spills, and deterioration.	B. Use transparency TRVB-3 or the chalkboard and list the sources of loss of rice kernels following harvest.
1. Contamination results when foreign materials get into rice grains.	1. Use transparency TRVB-4 or the chalkboard to explain contamination and ways of preventing it.
- Contaminants to prevent include pest dung (rats and mice), dead or live insects, pesticides, oil, rocks and pebbles, and straw and wood chunks.	- On a field trip to a rice storage facility, ask the manager to explain the kinds of materials that are found in local area rice that result in contamination. Collect samples of these materials (pebbles, hard clods of soil, sticks, wood pieces, etc.) and prepare a poster or display with information about how to reduce the contaminants.
- Some contaminants increase the need for cleaning during milling, with straw and wood chunks being examples.	
- Some contaminants make the rice unfit for milling and consumption, with pesticide and oil contamination being examples.	

- Always carefully clean a storage facility before the harvest season.

- Keep hauling and storage vehicles clean. (Never store pesticides or petroleum products in vehicles or storage areas that will later be used for rice.)

2. Spills result when harvested grains are lost in dumping from combine to carts or trailers, holes or unfastened openings in hauling vehicles, and when unloading.

2. Visit a rice farm during harvest season. Note the presence of spilled kernels on the ground where loading and moving rice have occurred.

- Rice that is spilled is lost.

- Keeping vehicles in good condition prevents holes and grain loss.

- Observe rice hauling vehicles on a farm. Note any defects that could result in the loss of grain. Prepare recommendations on how the losses could be prevented.

- Use care in dumping and moving rice to prevent losses. (Be sure all connections are in good order and that vehicles are properly positioned.)

- Haul rice in vehicles that are properly designed and maintained.

3. Deterioration results when the harvested kernels are cracked in moving or by improper moisture levels that allow decay.

3. Collect samples of rough rice. Note the presence of deterioration. Determine if the deterioration is due to high moisture, pests, contamination, or cracking from rough handling.

- Augers and other handling equipment should be designed and used to prevent kernel cracking.

- Properly dry rice kernels to remove excess moisture.

II. How is rice stored?

A. Rice is stored in bins or elevators.

1. Rice is stored as rough rice instead of milled rice.

2. Improper storage and handling can result in big losses.

- Rough rice is a living biological organism that gives off carbon dioxide, water vapor, and heat.

- The accumulation of the products given off by stored rice can promote the growth of microbes, such as molds and bacteria.

- The growth of microbes in stored rice causes increased biological deterioration.

- Air movement removes carbon dioxide from rice bins.

- Rice is dried before storing or at the time of storage.

- Control insects in stored rice by fumigating the entire bin filled with rice with an approved fumigant. (Caution: Never use an unapproved product on stored rice.)

- Loss to rodents (rats and mice) is controlled by removing trash and clutter around storage areas and using an approved rodenticide.

B. Rice is hauled from the field to dryers or storage areas equipped with dryers.

A. Take a field trip to a rice storage facility. Ask the manager to explain how the facility operates. Prepare a report on your observations.

- Ask students to explain why rough rice is a living biological organism. (Each kernel has an embryo inside.)

- Set up an experiment to test the effects of high moisture on rice kernels. Fill a pint jar about half full of properly dried rice. Cover it with a loose-fitting lid. Fill another pint jar about half full of rice that hasn't been dried and sprinkle a few drops of water on top of the kernels. Place a loose-fitting lid on the jar. Set both jars aside in a room or closet with a temperature of at least 70°F for two weeks. Check each jar. Note any differences. Place the samples back for an additional two weeks. Again note any differences. Mold may begin to appear in the rice that has not been dried.

1. Various equipment is used to move kernels into and out of storage areas.

2. Equipment should be properly adjusted to avoid damaging the kernels, as cracked kernels have low value in marketing.

1. On the tour of the rice facility, note how rice is moved. Air, augers, conveyor belts, and other methods may be used.

III. How is rice dried?

A. Rice is dried to reduce the moisture content to prevent deterioration in storage.

1. The ideal moisture content for storing rice is 12-14%.

2. Rough rice may have 20% or more moisture at the time of harvest.

A. Perform the experiment to determine the percentage of moisture in rough rice included in Unit V, Problem Area A, if not done in teaching that lesson.

B. Rice may be dried on the farm or at a commercial rice-drying facility.

1. On-farm dryers use gas-fired furnaces for heat and fans to circulate the warm air.

2. Most rice is dried in commercial drying facilities.

- 80% of the rice in California and 90% in the lower Texas Gulf Coast area is dried commercially.

- About half of the rice in the Mississippi River Delta is dried on the farm.

1. Take a field trip to a farm with drying facilities. Study how the facilities are designed. Have students prepare written reports of their observations.

- Take a field trip to a commercial rice dryer. Determine how the rice is dried. Also, determine what a producer needs to do to use the drying facilities.

C. Commercial drying is often preferred because of the expense of owning on-farm dryers.

1. Proper drying requires good facilities and people who know how to use them.

- Farms need to buy and properly install manufactured drying equipment with adequate capacity to meet the seasonal needs of rice drying. (Drying equipment is idle much of the year, with peak use during the harvest season.)

- Careful monitoring of temperature, air movement, and moisture content of rice kernels is needed to assure proper drying.

2. Contract with a commercial dryer well ahead of the harvest season to assure that space will be available at the facility for your rice crop.

1. Interview an operator of a commercial rice drying facility. (The person could be a resource person in the classroom.) Determine the kinds of skills needed and the nature of the work.

- On a field trip, observe the kinds of controls that regulate rice drying facilities.

2. Obtain a copy of the contract used by a dryer with growers. Have students review the information required and the regulations that must be followed.

Review: Have students summarize the content of each objective. Call on different members of the class to read an objective aloud and provide the information that covers it. Allow other students to assist in providing information. Use this as an opportunity to re-teach any content that appears not to have been mastered.

Application: Several application suggestions are listed here:
1. Have students test the moisture content in a sample of rice that shows mold or bacteria. (The rice will have grayish or brownish spots and may have a musty odor.)
2. Students can prepare slides for microscopic examination of a sample of molded rice. Have students sketch mold spores and other organisms that may be present.
3. Have students with supervised experience programs in the area of rice learn to properly store and dry rice.

Evaluation: Evaluation should focus on the extent to which the students have achieved the objectives. Strategies include:
1. Observation of student performance throughout the lesson and during the review.
2. Observation of the quality of the written reports that students are to prepare on their field trips.
3. Giving a written test (sample is attached).
4. Observation of student performance in supervised experience.

Name_____

Test
Rice Production and Marketing

Unit V: Harvesting and Post-Harvest Management
Problem Area B: Post-Harvest Management

Instructions: Answer the following questions. Be sure to spell correctly.

1. What is post-harvest management?

2. What are the three major sources of loss in harvested rice? Briefly define each.

3. How is rough rice a "living biological organism?"

4. The two microbes commonly found in improperly dried rice are _____ and _____.

5. How are insects controlled in stored rice?

6. What is the ideal moisture content for stored rough rice? _____%

7. What are the two major approaches in the location where rice is dried?

8. What is needed to properly dry rice?

OBJECTIVES

Unit V: Harvesting and Post-Harvest Management

Problem Area B: Post-Harvest Management

Upon completion:

1. Explain the meaning of post-harvest management.

2. Describe proper storage of rice.

3. Describe how rice is dried.

DEFINITION

Post-Harvest Management - procedures followed with harvested rice to assure a quality product reaches the market.

Following harvest:

- Losses and damage rob the producer of income.

- Most losses can be prevented.

SOURCES OF LOSS WITH HARVESTED RICE

1. Contamination of grain - results when foreign materials get into harvested rice.

2. Spills of harvested grain - occurs in dumping or equipment that has leaks.

3. Deterioration in quality of kernels - rice grains are damaged by cracking, excess moisture, or other ways.

PREVENTING CONTAMINATION

Rice contamination can be prevented by removing sources of contaminants.

Sources:

Pest dung
Dead or live insects
Pesticides
Oil (petroleum)
Rocks and pebbles
Straw and twigs
Wood chunks
Other, such as wire and dust

Unit VI: Marketing and Processing

Problem Area A: Marketing

Estimated Time: 3-4 hours

Purpose/Goal: This problem area develops an understanding of the processes in marketing rice, with emphasis on marketing channels.

Learning Objectives: Upon completing this problem area, students will:
1. Explain marketing.
2. Describe standards that apply in marketing rice.
3. List and describe the functions in marketing.
4. Describe marketing infrastructure.

Instructional Resources: The following instructional resources are recommended for use in teaching this problem area:

Essential: Transparencies TRVIA-1, TRVIA-2, TRVIA-3, and TRVIA-4.

Additional: Brochures and other materials on marketing rice.

Preparation: Use the following general strategy to introduce this problem area:

Explain that people in the United States want their foods to be wholesome and easy to prepare. They do not want to have to do a lot of preparation to get them ready to eat. Ask students to name examples of food and tell what is required to get the food products to the supermarket. Here are common examples: milk is transported from a dairy farm to be pasteurized and otherwise prepared for human consumption, packaged, and delivered to the local supermarket; bread is made from wheat that is harvested, dried, milled, and baked into convenient-sized loaves; and dill pickles are made from cucumbers that are harvested, hauled, graded, pickled, packaged, and shipped to the local supermarket.

Food products are now available in easy to prepare, ready to use forms. Compare foods to the raw product and ask how many families begin their meals with a raw product of chicken or cheese. Virtually no one slaughters chickens or makes cheese at home. Relate this to rice. Would people eat much rice if they had to prepare it from the rough or paddy rice form?

Move into the problem area by presenting the objectives using TRVIA-1 or the chalkboard.

Presentation: Use the following summary of content and suggested teaching techniques to provide the instruction.

Summary of Content	Teaching Techniques
I. What is marketing?	
A. Marketing is providing products to people in the desired forms.	A. Use transparency TRVIA-2 or the chalkboard to define marketing.
1. Rice marketing is having rice products in convenient forms for consumers.	
2. Marketing begins when the producer is deciding what will be grown.	2. Ask a student to explain how a producer's decision is a part of the marketing process.
- Producers must decide among alternative crops, such as rice or corn, that will result in the greatest return on investment in a crop.	- Invite a rice producer to serve as a resource person in class and explain how marketing is important from a producer's perspective.
- Rice producers must decide on the length of grain to plant--short, medium, or long.	
B. Rice is a commercial crop.	B. Call on students to explain the word, commercial--products produced that will be sold.
1. Rice is grown only to be marketed and not for use on the farm.	
2. The rice produced is sold by the grower and loses identity at about the time of sale, which means that the rice in a bin may be from several different farms.	2. Ask a student to explain the concept of lost identity.

C. Rice may be marketed through different channels.

1. The most frequent channel is for the producer to sell to the miller/processor.

2. In some cases, marketing cooperatives are used to consolidate the crop from several farms into a larger quantity.

3. Rice may go through a number of "routes" before it reaches the consumer, including how it is processed and the final marketing (including international trade).

C. Interview a producer to determine the marketing channels used locally.

II. What standards apply in marketing rice?

A. Standards in marketing rice include percentages of unbroken rice, measurements or units, percent moisture, and purity.

A. Ask a student to explain the meaning of the word, standard--the accepted form of something.

B. The price paid to a producer for rice is based on the milling yield, known as total rice.

1. Total rice is the sum of the head rice and broken rice in 100 pounds of paddy rice.

- Head rice is the percentage of unbroken whole kernels.

- Broken rice refers to kernels that are cracked.

1. Examine a small sample of paddy rice and determine the percentage of head and broken rice.

2. Harvesting at the proper time with equipment that is in good operating condition increases the percentage of head rice.

C. Standard units for measuring rice are used.

1. The standard unit for measuring in the United States is the hundred weight or cwt (1 cwt = 100 pounds).

1. Use transparency TRVIA-3 or the chalkboard to present the standard units for measuring rice.

- Other units of measurement include bushels and barrels.

- Have students practice various rice weight and volume calculations, such as the number of cwt, bushels, and barrels in 5,000, 63,000, and 109,000 pounds of rice.

- One bushel weighs 42 pounds.

- One barrel weighs 162 pounds.

2. Internationally, the standard units for measuring rice are the kilogram and metric ton.

- A kilogram is 1,000 grams, which is equal to 2.2 pounds.

- A metric ton is 1,000 kilograms, which is equal to 2,200 pounds.

D. The standard moisture content for marketing rice is 14%.

D. If not previously done, conduct moisture tests on samples of rice. Use samples from at least two different sources.

1. Moisture content is determined and adjustments are made in the weight of the rice in a bin or on a truck.

- Rice with different levels of moisture is equated.

- It would be unfair to pay the same for rice without equating moisture content.

2. Determining the amount to subtract for high moisture is easily done.

- An accurate measurement of the percentage of moisture is needed.

- Subtract 14 from the percentage of moisture in rice.

- Multiply the total weight of the rice by the percentage of moisture above 14%.

- Subtract the weight of the water in rice in excess of 14% from the total weight of the rice.

- Example: If 100,000 pounds of rice had 16% moisture, the percentage of moisture over 14 is 2; multiply 100,000 by 2 (100,000 x 2 = 2,000); and subtract 2,000 from 100,000, which gives an equated weight of 98,000 pounds.

E. Rice should have a minimum of trash, insects and insect fragments, and other foreign material.

1. Rice is mechanically cleaned to remove much of the foreign material.

2. Use the results of sample tests or hypothetical moisture test results to equate rice on the basis of moisture content.

- Have students apply mathematics skills. Inform mathematics teachers that these calculations are being made and collaborate on instruction.

E. Determine the presence of trash and other foreign materials in rough rice. Weigh a small sample of rough rice. Remove the trash and re-weigh the rice. Calculate the percentage of trash in rice by weight.

2. The presence of some kinds of foreign material makes rice unsuitable for consumption, with pesticide and petroleum residues being examples.

3. Rice should not have diseased kernels.

4. Follow the official guidelines on tolerance for foreign material in rice.

3. Note any diseased or malformed kernels in a sample of rough rice. The percentage of these should also be calculated. First, weigh the overall sample. Second, remove any bad kernels. Third, re-weigh the rice and determine the percentage of bad kernels.

III. What are the functions in marketing rice?

A. Marketing functions are the steps or processes in moving rice from the producer to the consumer.

A. Use transparency TRVIA-4 or the chalkboard to list the rice marketing functions. Ask students to offer comments that help clarify each function.

B. Eight rice marketing functions may be used with rice.

1. Assembling the product occurs after harvest.

- Rice is delivered from different farms to a central location.

- Commercial dryers and/or elevators may serve as assembly points.

2. Grading assures that rice has uniform quality and meets certain standards.

2. Have a local rice buyer discuss rice grading as a resource person in class.

- The amount of total rice (milling yield) is determined.

- Price paid to the grower is based on total rice.

3. Transporting is moving rice from one location to another as a part of the marketing process.

4. Storing is keeping rice until it is needed in the next marketing function.

- Storing occurs at several places between the farm field and the consumer.

- Proper storage is needed to maintain quality of the rice.

5. Processing or milling involves preparing rough rice into the forms desired by consumers.

- Some rice is milled and polished.

- Some rice is further processed into easy-to-prepare, pre-cooked forms.

6. Packaging is placing rice products in containers that maintain product quality and quantities for use by the consumer.

- How rice is packaged depends on the way it has been processed and the way the consumer will use the product.

- Labels are attached to packages providing information about the product.

7. Advertising and promotion are used to encourage rice consumption.

3. Ask students to name the different times in rice marketing that the product is transported--farm to dryer, dryer to mill, mill to wholesaler, and wholesaler to supermarket are examples.

5. Have students visit a local supermarket and make a list of the different ways rice is processed and packaged. Note the kinds of packaging and the information on labels.

- Compare the convenience of cooking rice that has only been milled and polished with pre-cooked rice that is boiled in its container.

7. Have students collect examples of advertisements promoting rice consumption and prepare posters or bulletin boards depicting their findings.

- Many kinds of advertising are used including newspaper, magazine, radio, and point-of-purchase.

- Promotion may include coupons, price discounts, recipe information, and other approaches.

8. Selling is a transaction between a buyer and a seller.

- Selling price must be agreeable to both.

- Selling price influences the amount sold. (As price goes up, the amount sold goes down and vice versa.)

8. Have students explain the difference between selling and marketing. (Selling is changing ownership; marketing is getting rice to the consumer in the desired form.)

IV. What is marketing infrastructure?

A. Infrastructure is the framework that allows rice marketing to be carried out.

A. Ask students to name examples of rice marketing infrastructure in the local community. If a deficiency exists, ask what would be needed to provide the facilities.

1. Infrastructure includes dryers, bins, transportation facilities, milling and processing facilities, and other components that support the marketing functions.

- Essential infrastructure must be available to producers.

- With international trade, ports and ships must be available.

2. Producers are often not large enough to fully provide all of these needs themselves; therefore, a rice industry emerges to provide the infrastructure.

2. Ask students to explain why individual producers are often not large enough to provide the needed infrastructure.

B. Infrastructure should exist before a rice crop is produced.

B. Ask students to explain why the needed infrastructure should exist before a rice crop is planted. (A crop could be grown with no way to get it marketed.)

1. Rice producers sometimes join together to form cooperatives in order to assure a favorable infrastructure.

2. Government agencies may assist with infrastructure, such as ports, terminals, and roads.

Review: Have students summarize the major content of each objective. Use TRVIA-1 or the chalkboard to list the objectives. Re-teach any areas where the students appear deficient. Students may also be asked to prepare short written reports on different aspects of rice marketing.

Application: Several application suggestions are listed here:
1. Have students investigate rice marketing using the Internet and World Wide Web. Here are three addresses that may be useful:

American Rice, Inc. - http://www.amrice.com/indes.html
Broussard Rice Mill, Inc. - http://www.inti.net/binfo.htm
International Rice Research Institute - http://www.cgiar.org/irri

2. Have students visit a supermarket and compare the costs of various rice products. Assess the costs on the basis of how the products have been processed and the amount of preparation needed for eating. Students should prepare brief written and oral reports of their observations.
3. Students with supervised experience in rice production and/or marketing should learn rice marketing from the perspective of a producer, miller, or other function in the rice marketing process.

Evaluation: Evaluation should focus on the extent to which students have mastered the objectives of the lesson. Three approaches are:
1. Observation of student performance throughout the lesson and during the review.
2. Giving a written test (sample is attached).
3. How students understand and use rice marketing in their supervised experience.

Name _____

Test
Rice Production and Marketing

Unit VI: Marketing and Processing
Problem Area A: Marketing

Instructions: Answer the following questions. Be sure to spell correctly.

1. What is rice marketing?

2. Why is rice a commercial crop?

3. What are the major areas where standards apply in rice marketing?

4. Define the following terms:

   Head rice -

   Broken rice -

   Total rice -

5. What are the standard units for measuring rice in the United States? Internationally?

6. The standard moisture content for marketing rice is _____ percent.

7. Why is moisture content of rice equated in marketing?

8. Name the eight rice marketing functions and briefly explain each.

9. What is rice marketing infrastructure?

OBJECTIVES

Unit VI: Marketing and Processing Rice

Problem Area A: Marketing

Upon completion:

1. Explain marketing.
2. Describe standards that apply in marketing rice.
3. List and describe the functions in marketing.
4. Describe marketing infrastructure.

RICE MARKETING

Rice marketing - providing rice products to people in the desired forms.

- Products are in convenient and easy-to-use forms.

- Begins when the producer is deciding what to grow.

STANDARD UNITS FOR MEASURING RICE

United States:

Hundred weight (cwt) is most common; equals 100 pounds

Also used:
Bushel (42 pounds)
Barrel (162 pounds)

Internationally:

Kilogram - 1,000 grams (g)
(1 kg = 2.2 pounds)
Metric ton - 1,000 kilograms (kg)

MARKETING FUNCTIONS

Assembling

Grading

Transporting

Storing

Processing/milling

Packaging

Advertising and promotion

Selling

Unit VI: Marketing and Processing

Problem Area B: Processing

Estimated Time: 3 hours

Purpose/Goal: This problem area develops an understanding of the major areas involved in processing rice.

Learning Objectives: Upon completing this problem area, students will:
1. Define processing.
2. Explain the milling process.
3. Describe rice by-products.
4. Identify causes of rice loss during milling and ways to prevent the losses.

Instructional Resources: The following instructional resources are recommended for use in teaching this problem area:

Essential: Transparencies TRVIB-1, TRVIB-2, TRVIB-3, TRVIB-4, and TRVIB-5.

Additional: Any materials on local rice processing.

Preparation: Use the following general strategy to introduce this problem area:

Present two samples of rice to the class. One sample is rough or paddy rice just as it comes from the combine. The second sample is polished rice as it comes from a bag or box from the supermarket. (It may be preferable for the sample from a supermarket to be rice that is easy to prepare, such as a "boil-in-the-bag" brand.) Ask students to compare the two samples. The students should list differences that are readily observable and attempt to describe what it took to make the form they would prefer to eat.

An additional step for this interest approach is to have students try to remove the hulls from some of the rough rice kernels. Some creativity may be needed to remove the hull without damaging the kernel. Three forms of rice are now observable in class: polished, hulled, and rough. Ask students how much they could hull by hand in a day and if the need for hand hulling would influence the amount of rice eaten.

If time permits, cook each sample and allow students to voluntarily taste and compare the palatability of the samples. Which do they like best? Why?

Move into the problem area by presenting the objectives using transparency TRVIB-1 or the chalkboard.

Presentation: Use the following summary of content and suggested teaching techniques to provide the instruction.

Summary of Content	Teaching Techniques
I. What is processing?	
A. Processing rice is all of the steps that are done to rough rice to prepare it for human consumption.	A. Use transparency TRVIB-2 or the chalkboard to present the definition of processing.
1. Some forms of rice require more processing than others.	
- Polished uncooked rice requires less processing than pre-cooked instant rice products.	
- Convenient, easy-to-use forms of packaging require more processing.	
2. Processing methods are used that retain the nutritional value of rice to the extent possible.	2. Have samples of rice in different forms for students to observe in the classroom.
B. Processing is a broad marketing function.	B. Ask students to explain how processing is a part of marketing. (Processing changes the product to meet consumer demand.)
1. Processing adds value to rice products.	
2. Processing makes rice more appealing to consumers and encourages consumption.	
C. Rice processing includes several major areas or procedures that prepare rough rice for consumption.	

II. What is rice milling?

A. Milling is a major step in converting rough rice into a form suitable for human consumption.

A. Use transparency TRVIB-3 or the chalkboard to explain milling.

B. Milling includes several procedures, with some variation, depending on the qualities desired in the final product. The procedures are:

B. If accessible, take a field trip to a rice mill. Have the manager explain how the mill operates, including the products and by-products that are produced.

1. Cleaning--Cleaning removes dirt, straw, and other impurities from rough rice. (This step is also known as precleaning.)

1. Examine a sample of rough rice to observe the need for cleaning.

- Screens are used to separate larger materials from the rice grains.

- Large fans blow away materials that are lighter than rice grains.

2. Hulling--Hulling removes the hulls without breaking the kernels.

2. Have students try removing the hulls from rough rice kernels by rubbing with their hands. Ask them to report their experiences. Ask them how they could do a better job--be more efficient.

- Machinery (known as a sheller) has been specially designed to keep from damaging the rice kernels.

- Large rubber rollers loosen the hulls. (Some shellers use stone disks.)

- The hulls are separated from the grain by a suction process.

- Observe a sample of hulls that have been removed from rough rice.

- A screen separates the hulled rice from any kernels that made it through the rollers with the hull still attached.

- The hulled rice may be packaged as brown rice though most of it goes to another step known as polishing.

3. Polishing--Polishing converts brown rice to white rice.

3. Observe a sample of hulled (brown) rice prior to polishing.

- A machine known as a huller is used to remove the outer layer on the rice.

- The outer layer on brown rice is known as bran.

- Observe a sample of rice bran.

- A polishing machine rubs off the bran layer and rice embryo.

- The remaining white material is the endosperm of the rice kernel--the part that is most widely eaten.

4. Grading--Grading is a step following polishing.

4. Study a sample of polished rice for defects that would affect its grade.

- Rice is sorted into different grades for marketing.

- Invite a person who works at a rice mill to visit class and describe the grades of rice.

- Grades are based on kernel size and quantity of damaged and broken kernels.

- In the United States, the highest quality rice is grade U.S. No. 1; with the lowest numbered grade being a U.S. No. 6. (U.S. Sample is the lowest grade of rice.)

5. Parboiling is a process that results in a product known as converted rice.

5. Have students read the labels on rice products at the supermarket to determine those which have been parboiled.

- Parboiling is done in some rice mills prior to milling, but after cleaning.

- In parboiling, the brown rice is soaked in water just under the boiling point and steamed under pressure.

- Ask students to explain how parboiling results in vitamins moving from the bran into the kernel.

- Vitamins from the bran soak into the grain and result in increased nutritional value in the kernel when it is polished.

- Parboiling also results in fewer kernels being broken in the milling process.

- Ask students to explain why converted rice is not as white as polished rice.

- Converted rice is not as white as rice that is not parboiled after polishing.

6. Polished rice may be made into a variety of easy-to-prepare forms.

- These rice products are sold at higher prices and result in greater returns to the processor.

- Ask students to explain why rice products that are easy-to-prepare are sold at higher costs than other rice products.
- Ask students why the producer gets no additional income from advanced preparation.

- Easy-to-prepare forms provide the producer no additional income.

III. What are the common products and by-products of rice?

A. Rice products are made from the kernel that has been processed in a variety of ways.

1. Examples of products include: boiled rice, baked rice, brown rice, fried rice, rice cakes, and steamed rice.

1. Have students bring labels or examples or various rice products to school.

2. Examples of products from rice that have been more highly processed include breakfast cereal (puffed rice, rice flakes, and cream of rice), rice flour, rice milk, and wine (known as saki in Japan).

2. Have students examine a sample of puffed rice cereal and compare it to rice kernels. How is the cereal like and different from a kernel?

B. Byproducts from rice are made from bran and hulls.

1. Bran is used in baking.

2. Hulls and bran are used in livestock feed.

C. Rice straw is used to make several products, such as paper, hats, baskets, and roof thatching.

C. Have students bring one or more items made from rice to the classroom for observation.

IV. How are losses of rice prevented during milling?

A. The milling process can damage kernels and otherwise cause losses.

B. The major losses in milling are in three areas.

B. Use transparency TRVIB-4 or the chalkboard to list the major sources of loss of rice.

1. Broken rice--The milling process can damage and break kernels.

2. Damage by pests--Insects, birds, mice, and rats can damage rice in storage.

3. Improper milling--Machinery may be adjusted or arranged improperly in a mill.

C. Milling losses can be prevented.

1. Use proper harvesting and drying practices to prevent cracking of rough rice.

2. Prevent damage by insects, rodents, and birds.

3. Dry rough rice to the optimum moisture content--13.5-14.0%.

4. Operate milling equipment properly.

C. Use transparency TRVIB-5 or the chalkboard to list ways of preventing losses during milling.

Review: Have students summarize the major content of each objective. Use TRVIB-1 or the chalkboard to present the objectives. Call on different students to explain the content associated with each objective. Re-teach any areas where student achievement does not reach the level of the objective. Students may also prepare and give oral reports on their observations of rice processing.

Application: Several application suggestions are listed here:
1. Have students investigate rice processing/milling using the World Wide Web. A few suggestions are listed here:

International Rice Research Institute - http://www.cgiar.org/irri
RiceNet Trader - http://www.ricenet.com/
The Lundberg Rice Paper - http://www.lundberg.com/ricepaper.html
The Rice Company - http://www.cgtd.com/global/rice.html

2. Continue application number 2 from Problem Area VIA. While at the supermarket, students should carefully determine the information provided on the ways rice products have been processed.
3. Students with supervised experience in rice processing should apply the content of this problem area. They can also assist by providing information about their experiences to the entire class with oral reports.

Evaluation: Evaluation should focus on the extent to which the students have mastered the objectives. Three approaches are listed here:
1. Observation of student performance throughout the lesson.
2. Giving a written test (sample is attached).
3. Performance of students with supervised experience in rice processing areas.

Name_____

Test
Rice Production and Marketing

Unit VI: Marketing and Processing
Problem Area B: Processing

Instructions: Answer the following questions. Be sure to spell correctly.

1. What is processing?

2. How does rice processing relate to marketing?

3. What are the procedures included in rice milling? List the six areas and briefly explain each.

   1.

   2.

   3.

   4.

   5.

   6.

4. What are three examples of rice products?

5. What use is made of the hulls and bran remaining from rice milling?

6. What are the major losses in rice milling? How are these losses prevented?

7. How does processing add value to rice?

OBJECTIVES

Unit VI: Marketing and Processing

Problem Area B: Processing

Upon completion:

1. Define processing.

2. Explain the milling process.

3. Describe rice by-products.

4. Identify causes of rice loss during milling and ways to prevent the losses.

RICE PROCESSING

Rice processing - All of the steps that are used to prepare rough rice for human consumption.

- Some rice products require more processing than others.

- Processing methods can be used that retain more of the nutritional value of rice.

- Processing adds value to rice (processed rice sells for a higher price than rice that has not been processed).

MILLING RICE

Milling converts rough rice into forms suitable for human consumption.

Milling procedures:

1. Cleaning

2. Hulling

3. Polishing

4. Grading

5. Parboiling (optional procedure; done before hulling)

6. Prepared into easy-to-prepare forms

RICE LOSS

The milling process can damage rice and cause losses.

Major losses are in three areas:

1. Broken kernels

2. Damage by pests

3. Improper milling

PREVENTING MILLING LOSSES

Ways milling losses can be prevented include:

1. Use proper harvesting and drying practices to prevent cracking.

2. Use proper storage practices to prevent damage by pests.

3. Dry rough rice to the optimum moisture level.

4. Operate milling equipment properly.

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